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ABOUT THIS MONTH'S AUTHORS

E. STEWART FREEMAN

Eliminating the Effect of Changing Price Levels on the Relation of Income to Investment. Mr. Freeman, after 46 years with Dennison Manufacturing Co., is retired and lives now in Cambridge, Mass. A previous contributor to the *Bulletin*, Mr. Freeman was awarded a 1955-56 Lybrand Certificate of Merit for the article which appears in this issue.

GEORGE W. FRANK

Let's Develop Return-on-Investment Consciousness. Mr. Frank is a Lecturer in Accounting, University Extension, University of Delaware, Newark, Delaware. Formerly, he was Associate Professor of Accounting at the University of Maryland. A previous contributor to the *Bulletin*, Mr. Frank was awarded Lybrand Certificates in 1952-53 and 1955-56.

OTAKAR KUTVIRT

Departmentialization of Return-on-Investment. Mr. Kutvirt is Staff Assistant to the Comptroller, Kodak Park Works, Eastman Kodak Co., Rochester, New York. Prior to his present position he taught economics at the University of Rochester and was associated with Rochester Bureau of Municipal Research.

W. G. LIVINGSTON

Clarifying Return-on-Investment Determinations. Mr. Livingston is Staff Assistant to the Vice President of Finance, The Chemstrand Corporation, Decatur, Alabama. He is in charge of this company's Special Studies Section. Mr. Livingston is represented here by an article which received a recent Lybrand Certificate of Merit.

ROBERT C. PERRY

Accounting Procedures Add Up to Service. Mr. Perry is Division Controller, New Products Div., Corning Glass Works, Corning, New York. Prior to his current assignment, he was a member of the Controller's Staff of this company, in charge of Accounting Systems. Recipient of a Lybrand Certificate of Merit for this manuscript, Mr. Perry is a previous contributor to the *Bulletin*.

PATRICK J. McCULLAGH

A Cost System for a Frozen Meals Manufacturer. Mr. McCullagh is Chief Accountant, Fredela Frozen Food Corp., Los Angeles, Calif. Before coming to the U. S. in 1953, Mr. McCullagh was a regular officer of the Irish Army. He is a member of the Institute of Cost and Works Accountants. (England).

RICHARD C. JOHN

Accounting for Financial Control in a Professional Stock Theatre. Mr. John is the Accounting Officer of the University of Wisconsin, Milwaukee, and serves as Accounting and Budget Control Advisor to several theatres, including the Fred Miller Theatre in Milwaukee. For several years, he taught Retail Management and Control at the University of Wisconsin, Milwaukee.

ALEX L. HART

Using Probability Theory for Economy in Cost Control. Mr. Hart is Head of Alex L. Hart Associates, Centerport, New York. He received his Ph.D. degree from the University of Minnesota in the fields of Business Administration, Economics, Statistics and Mathematics. He has previously published several articles pertaining to the application of statistics.

JAMES C. STEPHENSON

Quality Control to Minimize Cost Variances. Mr. Stephenson is Controller, Utopia Cleaners and Dyers, Inc., Birmingham, Ala. He has been associated with this firm since 1950. Prior to that time he held various executive positions with National Coal & Coke Company and affiliated mining companies.

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N.A.C.A. BULLETIN

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Eliminating the Effect of Changing Price Levels on the Relation of Income to Investment

by E. STEWART FREEMAN

Formerly on Staff of President, Dennison Manufacturing Co., Framingham, Mass.

That the nearly continuous changes in the price level which have characterized the past century, especially the past fifteen years, affect apparent profit and financial position of companies as shown by conventional financial statements has been a fairly frequent point of observation. Correction of accounting practice in statement presentation has been suggested by many, including the present author. This thesis is re-presented here because of the effect of changing price levels on both income and investment and hence on the relation between them, an old subject which has recently been re-emphasized.

THERE HAS BEEN a revival of interest in the relationship of income to invested capital, so much so that some appear to regard it as a new topic. There also appear to be a variety of ideas as to how this relationship should be measured. This article will examine some of these ideas and will suggest methods of measurement. First, however, some background is needed.

Our concepts of both income and investment have changed with the years and may not yet have reached maturity. Not so long ago, net income was conceived as the amount which could be distributed during the year without impairing the net worth at the beginning. Net worth was the amount the stockholders could expect to get out of the business if it were liquidated. For these purposes we needed values but, as values became more difficult to obtain, we came to use costs instead. We used them first as reflections of values, and later as substitutes for them. Then, for tax objectivity, we forswore values and took up costs as measures of investment. Thus, net income came to mean the excess

of gross revenue realized over the costs fairly chargeable against them. By that time, the function of the balance sheet had been reduced to that of showing merely balances carried forward. This left real values to be determined by the capitalization of net income and dividends in the trading processes of the stock market.

Two principal advantages have been claimed for this use of cost instead of value for income determination. First, it postpones recognition of gain until it is realized. This is good to the extent that taxes and dividends are postponed until the money is available but bad if it delays the recognition of changes in value by management. Secondly, cost is easier to obtain and measure than value but costs can be, and commonly are, translated from one kind of money to another without loss of objectivity.

When dear dollars are deducted from cheap dollars, the apparent profit includes amounts not available for any purpose other than the maintenance of the pre-existing purchasing power of the capital. When cheap dollars are deducted from dear dollars, amounts no longer required as capital are treated as if they were losses. This violates a long-established accounting principle that non-recurrent and extraneous gains and losses should be differentiated from normal income. Report readers cannot separate such amounts for themselves, because they have no means of translating the carry-over of past costs into the same kind of dollars as the revenues from which they are deducted.

Committees of leading accounting associations have suggested that individual companies experiment with the translation of their accounts into current dollars. While original entries must be kept in dollars of the time of expenditure or receipt, the carry-over from one year to the next should recognize the difference between the dollars of the respective years.

Reporting the effects of the capital levy, commonly called inflation, would not change the supply-demand relation between money and goods. Like the reporting of the income tax, it would be designed not to change the tax itself or its incidence but to show what is left for other purposes after the tax has been met. It would make inflation appear very much less profitable, and this should help the advocates of sound money. Nor will overstating the amount available for dividends when prices are rising and understating the amount available for wages when prices are declining help the people who want inflation for the purpose of redistributing wealth. Labor would be better off if the reported income were reduced when prices are rising and increased when they are declining, because this would be more likely to contribute to the stabilization of employment.

ADJUSTMENTS TO DETERMINE CURRENT-DOLLAR INVESTMENT

(thousands of dollars)

Items	Conventional Sheet in Mixed Dollars		Intermediate Sheet	Proposed Balance Sheet in Current Dollars	
	End of Preceding Year (1)	End of Current Year (2)	Column (1) in Common Dollars (3)	Beginning of Current Year (4)	End of Current Year (5)
MONEY BALANCES					
Cash	2000	2000	2000	2100	2000
Receivables	2400	2500	2400	2500	2500
Total	4400	4500	4400	4620	4500
Payable	3000	3250	3000	3150	3250
Net Money	1400	1250	1400	1470	1250
DEFERRED COSTS, current					
Inventories	4000	4200	4000	4200	4200
Prepaids	200	200	200	210	200
NET CURRENT ASSETS	5600	5650	5600	5880	5650
DEFERRED COSTS for Buildings, Machinery, etc.					
Cost	10000	10600	14200	14910	15360
Charged to Past	3500	3650	4800	5040	5220
Chargeable to Future	6500	6950	9400	9870	10140
TOTAL INVESTMENT	12100	12600	15000	15750	15790
DERIVATION OF INVESTMENT					
Capital Stock, par	6000	6000	6000	6000	6000
" "					
Excess over par	0	0	2000	2400	2400
Savings from Income	4100	4600	5000	5250	5300
Stockholders' Investment & Corporate Savings	10100	10600	13000	13650	13700
Long-Term Debt	2000	2000	2000	2100	2000
Deferred Credit for) Debt Shrinkage)	0	0	0	0	90
TOTAL CAPITAL	12100	12600	15000	15750	15790

NOTES:

Column 3 represents Column 1 adjusted to common dollars. It is not necessary after first year.
As a 5% price increase is assumed; every item in Column 3 is factored by 105% to obtain amounts in Column 4.
Inventories assumed to be at current cost; "lifo" and others which are not would require further adjustment
Fixed asset adjustments require reference to Exhibit 2
Related income adjustments dealt with in Exhibit 3.

EXHIBIT 1

The Balance Sheet — Each Year in Its Own Dollars

A good way to do this is exemplified in Exhibit 1. The three initial columns are preparatory. The first two are the conventional mixed dollar balance sheets which enclose the year. The third puts the opening balance sheet into common dollars, i.e., dollars all of one date. The first two columns will not be needed another year. The middle one will be provided for the next year by the final column, the adjusted closing balance sheet of the current year. In fact, in future years, only the final two, which are on the same dollar level, will be

needed if the opening balance sheet is footnoted to indicate the price level to which it has been adjusted from the closing balance sheet of the preceding year.

For now, all five columns are needed to show what we are doing to the conventional figures. Nevertheless, inspection will disclose that the specific changes on Exhibit 1 are not numerous. Changes in durable asset and accumulated depreciation figures (with corresponding adjustments to the "other side" of the balance sheet) convert the conventional closing balance sheet of the preceding year to a common dollar balance sheet (by-up-dating dollars in durable assets) which, in turn, is converted to the current-year closing price level by factoring all items by 105, as in Column 4. The current-year closing balance sheets, on the conventional basis in Column 2 and the common dollar basis in Column 5, are alike except for the updating of durable assets in the latter.

It has been assumed for simplicity that the inventories as well as the money items in Columns 1 and 2 were already in dollars of their respective years. Hence the only change in the net current assets is the 5 per cent addition required to translate the closing balance sheet of the preceding year into current dollars for the opening balance sheet of the current year. If the inventories had been priced differently, e.g., "lifo", base stock, three-year average, etc., it would have been necessary first to translate them into current dollars. The adjustment made adds $280,000 to the opening balance sheets which will be commented on when we get to the income statement. It changes a $50,000 increase between the conventional opening and closing balance sheets into $230,000 decrease, between Columns 4 and 5.

To up-date dollars in buildings, machinery, and other equipment, (before applying the one-year price-percentage adjustment applicable to all assets as between the preceding and current year), the cost for each depreciation-rate group should be classified by year of expenditure and each group factored in ratio to the change in the price level up to the end of the preceding year. The corresponding accumulated depreciation can then be figured on the revised cost at the appropriate rate. This translates the durable assets and the accumulated allowance for depreciation into current dollars at the end of the preceding year, i.e., into the same dollars as the current assets at that time.

It is assumed that these changes from mixed to current dollars produce the change from Column 1 to Column 3 of Exhibit 1 and to the first horizontal line of Exhibit 2. The second horizontal line of Exhibit 2 shows the influence of the 5 per cent price increase between the years. The last line of Exhibit 2 produces the figures in Columns 2 and 5 of Exhibit 1. The change in depreciation will affect the income, as will be commented on shortly.

Before doing so, we may still attend to the balance sheet and note what hap-

ADJUSTMENTS OF BUILDING, MACHINERY, ETC., COSTS

(thousands of dollars)

Item	Asset Cost		Depreciation		Net Deferred Cost	
	Mixed Dollars	Current Dollars	Mixed Dollars	Current Dollars	Mixed Dollars	Current Dollars
End of Preceding Year	10,000	14,200	3,500	4,800	6,500	9,400
Beginning of Current Year	10,000	14,910	3,500	5,040	6,500	9,870
Discards	(-250)	(-400)	(-250)	(-400)		
Purchases					850	850
Depreciation			400	580	(-400)	(-580)
End of Current Year	10,600	15,360	3,650	5,220	6,950	10,140

The revised figures on the second horizontal line equal 105% of the ones on the first line. No salvage has been assumed. If any exists, it would be in current dollars. The conventional income would be reduced by the $180,000 increase in depreciation, as shown in Exhibit 3.

EXHIBIT 2

pens on the liability side as a result of translating all assets into the current price level. A $2,000,000 debt payable in ten years has been assumed. At the end of each year, this debt remains constant in dollars. However, as between the two years which we are considering, distinguished by 5% depreciation of the dollar, the burden of this debt is correspondingly lowered. The resulting gain is, in some respects, like that from the current sales of bonds at a premium. The gain in such cases, like the increased dollar cost of the buildings, machinery, etc., should be spread over the remaining life. Thus the $2,000,000 at the end of the old year becomes $2,100,000 at the beginning of the new but is back to $2,000,000 at the end, with $10,000 (one-tenth) of the $100,000 gain credited to income of the current year and $90,000 switched to a deferred account.

(If, the next year, prices rise another 5 per cent the $2,090,000 total at the end of the current year would become $2,194,500 at the beginning of the year which follows. One ninth of the excess of this amount over $2,000,000, or $21,611.11, would be credited to that year's income, leaving the $2,000,000 plus a $172,888.89 deferred credit at its end. This credit, together with any further adjustments, would be spread over the remaining 8 years. By the tenth year only the $2,000,000 should be left.)

Some have proposed that preferred stock should be treated in a similar manner. The amount assigned to preferred stock, however, has no meaning except

ADJUSTMENTS TO DETERMINE CURRENT DOLLAR INCOME

(thousands of dollars)

Item	Changes in Net Income	Conventional Net Income	Current Dollar Net Income
Conventional Net Income		1000	1000
Shrinkage of Purchasing Power or Working Capital	(-280)		
Increased Depreciation	(-180)		
Total	(-460)		
Less Allocated Gain from Shrinkage in Purchasing Power of Long-Term Debt	10		
	(-450)	0	-450
Net Income		1000	550
Cash Dividends		500	500
Retained or Saved		500	50
Stockholders' Investment			
Beginning of Year	3550	10100	13650
End of Year	3100	10600	13700

If the income is compared with a total investment figure which includes long-term debt this $10,000 would not be added to income nor would interest on the debt be deducted from it.

EXHIBIT 3

in respect to liquidation or call and dividends on preferred stock are allocations of, and not deductions from, net income.

Income Effect of Using Current Dollars

Income results of moves described in Exhibits 1 and 2 are assembled in Exhibit 3. In our illustrative data, $280,000 is removed from conventional net income when net current assets in opening and closing balance sheet are stated on the same price level; $180,000 is further taken out as increased depreciation when durable assets are restated in the year's own dollars; and $10,000 is added to income to reflect pro rata debt shrinkage because of price level change. On this basis, the income of each year is wholly computed in dollars of the same year.

The difference between the 10,100,000 year-of-purchase dollars and the 13,650,000 current dollars shown near the bottom of Exhibit 3 is not part of the income of any period nor can it properly be labeled as "appreciation." It is

like the difference in figures between 62,137 miles and 100,000 kilometers or between one gallon and four quarts or five fifths. Distance, volume, and value are not changed in any way by the substitution of one unit of measurement for another.

The tax authorities would not be expected to accept this point of view until after it has been generally recognized. Government represents the majority and, in technical matters, the majority always lags behind the leaders. Under current tax theory the $3,550,000 difference consists of a $180,000 offset to an unrecognized current loss and $3,370,000 unrealized appreciation of buildings, machinery and other requirement.

For tax purposes this appreciation will be realized as the depreciation allowance is earned at the higher price level but charged off at the lower level. As it is now, the selling price tends to rise pro rata with the price level while the depreciation allowance remains constant in amount. Thus, now the depreciation declines and the income tax rises in percentage of sales. Under the proposed plan, the tendency would be for the depreciation allowance and the income tax to maintain their respective relation to sales and thus to eliminate government profiteering from this source.

If increases in dollar value that do no more than offset the depreciation of the dollar must be taxed as capital gains, then it would be fair to tax the appreciation of depreciable assets as it is realized through the difference between depreciation at the old and at the new price levels. The tax rate on the differential, however, should be limited to that on capital gains. The rate used for excess profits taxes, or even the normal corporate rate, is not justified.

The proposed method brings the past up to date in the opening balance sheet of the year. In this it differs from that of "lifo" which postpones the correction to some indefinite future. Also, the same method is naturally applied to all items on the balance sheet, whereas "lifo" is designed and used only for current inventories.

Correction for changes in the purchasing power of the aggregate dollar capital is proposed instead of the substitution of the replacement cost of specific assets. Either the indexes used in the President's Economic Report for correcting the gross national product or the more familiar consumer's price index can be used for this purpose. Adjustments for changes in price within the year are not proposed because it is only the changes of longer duration that require the impounding or permit the release of dollar capital. The plan is aimed not at short-term precision but rather at results similar to those obtained through depreciation accounting. In the one case as in the other, the margin of error would be compensatory rather than cumulative. Accounting would be improved

as much by recognizing changes in the value of the dollar as it was earlier in the century by recognizing the depreciation of durable assets.

Basic Relationships Clarified by Isolating Price Change Effects

The purpose of the foregoing paragraphs has been to explain how to offset the effect of changing price levels on both the costs which are deferred on the balance sheet as part of the investment and the costs derived therefrom which are deducted from revenues to obtain net income. Numerical comparisons are valid only when a common denominator is used. Currencies of different places cannot otherwise be compared and neither can the dollars of different periods of time.

The following paragraphs will go on to discuss ratios of net income to investment and to sales, both with respect to usefulness and various considerations affecting validity. Each ratio has its place. The percentage of net income to sales (and/or other gross revenues) is likely to be more useful in the short run and that of net income to investment in the longer run. During the ups and downs of business, net income is likely to fluctuate most, sales next, costs less and investment least.

When the price level rises or falls, parts of the conventional investment are likely to lag from one to twenty or more years behind. Any concern attempting to tie income too closely with an investment so measured would be likely to run out of capital on the upswing or out of markets on the downswing. The investment should be translated to current dollars, as has been described. But is the ratio needed? It might be supposed that, because the net income is derived from the sales, it is most naturally related to it and, further, that the investment might vary somewhat as the percentage of income to sales does. Why can we not rely wholly on this?

There are some observations relevant here. The percentage of net income to sales tells what the customer is being asked to contribute. It reflects his ability and willingness to pay, which should vary with the general price level. But it may bear little relation to the investment. Usually the customer will be willing to pay more per asset hour, and even per sales dollar, for ingenious creations composed of higher quality material than for the routine processing of cheaper stuff. This situation suggests a gauge of what is possible in pricing. It does not give the longer picture when considerations of growth are involved.

The investment figures are most likely to be useful when they can be related to the current problems of a growing business. Although, when a business is not growing, past investments and the sunken costs based on them are likely to have

only academic interest, the decisions of a growing concern can be helped by projecting into the future such past experiences as are likely to be repeated. For this purpose, investment figures are useful, the more so after they have been translated from the ancient into the living language (purchasing power).

The ways in which return requirements relate to sales and to investment may be simply set forth. If the price level were stable, a company which was not growing would need net income only for cash dividends, which for all manufacturing companies in the United States has recently averaged 2.2 per cent of sales, which probably is about 4 per cent of the investment. However, a 3 per cent of growth, for example, would require savings from income equal to 3 per cent of the investment. As estimated in Exhibit 4, this would be 1.73 per cent of annual sales and, if the cash dividends are to average 2.2 per cent of sales, the total net income would need to be 3.93 per cent, of annual sales as in Column 2 of that exhibit.

In short, no flat rate of return on the investment should be established without due consideration of the relative age and prospects of the company's product or products. The more a company is able to earn in excess of reasonable cash dividends, the more likely it is that the market for its product has room for growth, and the faster the rate of growth it will be able to finance. On the other hand, if the market price will not provide enough income to finance the contemplated rate of growth, that may mean that the rate of growth should be reduced. The market for the product may be approaching saturation or competitors may have lower costs.

In discussing capital requirements, we can scarcely avoid commenting still further upon price level changes, which have been the focus of attention in this article. When the general price level rises or falls, the requirements which necessary additions to investment impose upon net income, if determined in the conventional manner by applying costs of many years, are increased or diminished. The effects of a 10 per cent change in the price level up and down are shown in Columns 3 to 6 on Exhibit 4. When the general price level moves up or down, the sales and the current expenditures for buildings, machinery and other equipment (for both replacement and expansion) should move up or down very much as sales do. This general similarity of variations would extend to net income if, as proposed, the depreciation allowance also changed with the price level. Under conventional depreciation, however, based on the old cost level rather than that in which capital expenditures are being incurred, the insufficient charge to income creates, when prices are rising, an unsatisfied claim (a sort of contingent liability to make up a capital loss) against the conventional net income. When prices are declining, the conventional deprecia-

tion allowance provides more out of income than is needed for replacement. However, expenditures in any year would vary with the price level and, under the accounting plan proposed in Exhibit 1, so would the depreciation allowance.

We need to say something about that portion of the assets in which the working capital is invested. The percentage of working capital to sales, here assumed to be 24 per cent, needs to be maintained regardless of whether the change in sales is due to physical volume or to unit prices. For 3 per cent physical growth, 3 per cent of 24 per cent, or 0.72 per cent, of sales at the current price level would be required. A change in the price level would involve also a pro rata change in the amount of working capital required to finance the pre-existing physical volume. For example, a 10 per cent price increase would require additional dollar capital equal to 10 per cent of 24 per cent, or 2.4 per cent, of sales. A 10 per cent price decrease would release capital equal to 2.4 per cent of sales. Here the capital needs for a specific purpose are based on the standard, i.e., the assumption that previous needs were precisely met. In Exhibit 1 the loss to be recorded was based on the actual net assets at the end of the preceding year, i.e., on what there was to lose. Although the purpose differs, the principle is the same.

Thus, under the assumed conditions under conventional net income determination, a 10 per cent increase in prices would increase the needed net income by an amount approximately 2.6 per cent of sales (the excess of Column 3 over Column 1 and of Column 4 over Column 2 in Exhibit 4.) If selling prices rise when purchase costs rise (instead of being delayed until the inventory at the old costs is consumed), the conventional net earnings should have no difficulty in supplying the amount required. The difficulties arise from popular misunderstanding, abetted by accounting convention, which, not recognizing the need for additional capital, seeks to divert such amount into taxes or employee benefits. When the 10 per cent change in the price level is downward, the need for conventional net income is reduced by an amount approximating 2.6 per cent of sales, the amount by which Column 5 is below Column 1 and Column 6 is below Column 2 in Exhibit 4. If this reduction in need were fully realized, some of the pressures on costs which tend to deepen depressions would be relieved. Much good might, therefore, be derived from separating the effects of price changes from normal income and the easiest and most effective way to do this is the one to which the forepart of this article has been devoted and which has been illustrated in Exhibit 1.

NET INCOME REQUIRED TO MEET CAPITAL NEEDS EXPRESSED AS PERCENTAGE OF SALES

Purpose for Which Required	At Constant Price Level during Life of Depreciable Assets		First Year of Price Change			
			If 10% Price Increase		If 10% Price Decrease	
	No Physical Growth (1)	3% Annual Growth (2)	No Physical Growth (3)	3% Annual Growth (4)	No Physical Growth (5)	3% Annual Growth (6)
To spend for buildings, Machinery & other equip.						
For replacement	2.40	1.64	2.40	1.64	2.40	1.64
For expansion	0.00	1.80	0.00	1.80	0.00	1.80
Total expenditure	2.40	3.44	2.40	3.44	2.40	3.44
Obtainable from allowance to offset depreciation	2.40	2.43	2.16	2.19	2.64	2.67
Remainder from net income	0.00	1.01	0.24	1.25	(-0.24)	0.77
Working capital						
For added volume	0.00	0.72	0.00	0.72	0.00	0.72
For price change	0.00	0.00	2.40	2.40	(-2.40)	(-2.40)
Total Retained Income	0.00	1.73	2.64	4.37	(-2.64)	(-0.91)
Cash Dividends	2.20	2.20	2.20	2.20	2.20	2.20
Total Net Income Required	2.20	3.93	4.84	6.57	(-0.44)	(-1.29)

Note:
The buildings, machinery and other equipment have been treated as one group, with a gross cost averaging 60 per cent of annual sales and an average life of 25 years. In practice it would be desirable to divide them into at least three length-of-life groups.

EXHIBIT 4

Net or Gross Figures for Investment?

Some recent writers have argued that investment should be measured by the gross assets without any deduction for depreciation. The present writer disagrees. An investment is something separate and distinct from the media through which it is made. It is an advance of money which the investor expects to get back, together with some reward for the venture. Its status as an investment is determined not by physical possession or title to the media or instrument used but by the prospect of future recovery of the money. The purchase price of a machine should be regarded as the prepaid cost for the number of machine years of production expected. Its value, and hence the limit to its investment status at any time thereafter, will depend, not on its current mechanical efficiency but on the number of years of future production it can promise. Each year this number will decline and the decline should be offset by cash withheld from gross revenues.

An over-simplified example may help. Assume that a business starts with capital of $20,000, all in cash. It then buys a machine with a twenty-five year life and thus divides its capital into $10,000 cash, $10,000 machine. Each year, $400 is charged against the revenues as an allowance for depreciation and,

as a result, $400 from the revenue is left in the cash account. At the end of the 25 years, the investment will be: cash $20,000, machine nothing. Further assume that the machine is replaced and the capital is divided exactly as before. If the depreciation is ignored, the investment would *appear* to climb $400 a year from $20,000 at the start to $30,000 immediately preceding replacement when it would at once drop back to $20,000 cash and, upon replacement, would become cash $10,000 plus machine $10,000. In a more complicated series of events this duplication (within the total assets figure as it appeared to rise from $20,000 to $30,000) would be disguised but not changed.

The function of depreciation accounting is not to save up money for the replacement of specific assets at the end of their lives. Rather, it is to maintain the aggregate invested capital by providing substitute assets currently (originally cash from revenues) to replace the aggregate asset consumption (depreciation) of the year. Thus, in adjustments to a year's own dollars exemplified in Exhibit 1, we were not concerned with the future replacement cost of any asset. The need there recognized and attempted to be met in a practical way is, rather, that the amount returned to the cash account during the current year should be equivalent in purchasing power to the cash originally paid for the asset consumption of the year. The cycle of investment is not from one investment to its replacement but from free, unpledged and uninvested cash back to the same sort of cash and a new option for management.

There is a corresponding point to be made with respect to working capital. It has usually been considered as equal in amount to the net current assets, because the current liabilities have not been classified as capital. But recent writers who advocate the use of the gross current assets as working capital would change this and would treat all liabilities as part of the invested capital. Let us, therefore, examine the nature of current liabilities. They are principally of three kinds: offsets to assets entered in the accounts before any money has been invested in them, taxes and other trust funds collected for others but not yet turned over by the agent to the principal, and capital loans due within the current year.

Concerning the first, it may be assumed that purchases not yet paid for are still investments of the supplier in his accounts receivable. The selling price of the supplier, which is the cost to the purchaser, will provide all the return that is to be made on this investment. The purchaser's net income should not be expected to duplicate the return on the investment which his cost has already provided. His accounts payable should be offset against either the assets purchased or the cash to be paid for them. As in the case of depreciation, the results

of double entry bookkeeping are distorted when we count only the debits and ignore the offsetting credits.

As to the second category of current liabilities, when a company acts directly or indirectly as agent for the Government in collecting taxes or handles other trust or semi-trust funds, the amounts not yet paid over to the principal should either be excluded from the company's assets or at least offset by the debt. The first would be logical for a trust fund and the second for debts which have priority. Taxes, social security payments, and other contributions, as well as employee savings deducted at the source and taxes levied on payrolls, production, sales, and statutory net income, come under this heading. In some cases it might be illegal and in other cases merely unethical, to expose such funds to the general risks of the business. (Because of changes in income, tax rates, and time of payment, taxes on income have been an undependable source of capital, and most companies have, to a considerable extent, prepaid them by investing in Government securities.)

With respect to our third kind of current liability, amounts borrowed from financial institutions are properly classifiable as capital but, if they are required for only a small part of the year, they are not subject to the same risks nor are they useful for the same purposes as longer-tern debt. Sometimes such debts can be assigned directly against some specific part of the business which is more subject than other parts to seasonal peaks. Parts of long-term debts which come due currently and debts which are long-term debts in fact, even though short-term in form, might well be treated as part of the long-term capital.

Current liabilities, therefore, should in most cases be deducted from the current assets to obtain the figure for working capital. If, however, too much reliance is being placed on current debt, that may mean that the standard capital, which the company should try to maintain and on which it should strive to earn a return, should be established at a figure higher than the actual invested capital.

Let's Develop Return-on-Investment Consciousness

by GEORGE W. FRANK

Lecturer in Accounting, University Extension, University of Delaware, Newark, Del.

For many years, industrial accountants have trained themselves and others in consciousness of cost factors. Convinced that accounting will be more useful in management when it regularly includes determination and reporting of return on investment, realized by each principal product, the present author points out the fundamental character of this return as an indicator of the success of an enterprise and places its determination on a par with cost determinations. The presentation continues with suggested procedures and bases for investment allocation, further supporting the practicability of this management accounting activity.

PERHAPS MANAGEMENT IS justified in not devoting as much of its time to his reports as the accountant thinks they deserve. More often than not they contain only half the story. Management is interested, not only in receiving reports which analyze the makeup of earnings but equally, and perhaps even more, in knowing what return is being realized on funds tied up in equipment and working capital. Further, the extent to which investment is usually analyzed and reported, when this side of the picture is attended to, is simply to derive ratios relating various earnings and investment factors, such as earnings to total investment, fixed investment to total investment, fixed investment to net worth, etc. This type of ratio analysis, although important and useful, only begins to scratch the surface of the wealth of meaningful information which can be "mined" through the proper accounting, analysis and reporting of investment data.

An attempt will be made here to show how the accountant can adapt to investment information some of the analysis and reporting procedures used for costs and income, and thus give all concerned the complete financial story. It is possible to establish procedures through which the monthly returns being realized from the investment used by each product can be determined. Then, management having both the income and the investment return resulting from each of its products, has in its possession just about all the information it can expect from the accountant and, therefore, should certainly make full use of all his reports, something the accountant so much desires. However, to bring about this realization, the accountant must first show some investment consciousness.

Starting Point for Awareness of Investment

He may need to look about for help. It soon becomes obvious that there is very little to be found in any of the cost accounting texts on recognized and accepted procedures for allocating investment to products. Probably the main reasons why it is difficult to locate written material associated with investment distribution is that cost accountants have not kept pace with, or have overlooked, the implication of the fact that the operations of most firms have become increasingly diversified. Hence, only to indicate what a firm's total investment is and derive a few over-all ratios is entirely inadequate. The value of separately accumulating the cost of products manufactured and of preparing income statements which show the earnings contribution of each is recognized but not that investment deserves the same detailed treatment. It is just as important to be informed of the investment dollars needed to bring about these product earnings and to compute the return being realized on this investment.

There are signs of an awakening. It is becoming increasingly obvious from the number of articles on the subject appearing in accounting periodicals that the lack of recognized investment allocation procedures is bothering accountants. Certainly it requires little imagination to realize that it is quite possible for a product's earnings to appear satisfactory but to find that these earnings are not resulting in an adequate return on the investment needed to make them possible. After all such a return is the real reason for making capital available for the manufacture and sale of the product. Analysts must, of necessity, increase their consciousness of investment. Total investment has to be broken-down and allocated to various products manufactured if any financial analysis is to be considered complete.

Therefore, the accountant must think in terms of "what products use what investment", the returns (monthly) on these products, forecast returns for existing products, expected returns for proposed new investments, whether there is a cost factor representing return on investment in every sales price estimate, and whether there is a return on investment statement for every cost or income statement issued. In other words, the accountant should be as investment conscious as he has long wanted management to be cost conscious.

The Bugaboo—Allocation Difficulties

Discussion with individual accountants as to why they do not determine the investment being used by each product indicates that, even where they have considered the possibility, they have not been able to come up with what they consider to be satisfactory bases for distributing total investment. It is gener-

ally believed that there would have to be many arbitrary allocations which would lead to much inconsistency and misinformation. Individuals of this turn of mind probably recall many past disputes as to correct bases for prorating overhead items to products. Much of the unwillingness of accountants to plunge into the field of investment distribution may stem from lack of information as to how the job can be done in a way that will give meaning to the results, and their natural reluctance to get into anything else which appears to be as difficult to tie down logically as is most accounting for overhead.

(This situation is not widely dissimilar from that which prevailed with respect to distribution costing several years ago when very little analysis was made of such costs. However, as procedures have been developed and accepted theory has become available, selling and administrative costs have been successfully allocated to products, territories, and classes of customers. Information so assembled and reported takes on much additional meaning and is usable in promoting the efficiency of the distribution operations. A like result may be predicted for analysis and interpretation of investment dollars.)

This is natural. There is always a certain amount of hesitancy about getting into detail about anything which apparently involves making many arbitrary allocations. To overcome this hesitancy it is helpful to recall the definition of accounting which states that it is, "the science and the art of systematically recording, presenting, and interpreting financial facts" and to realize that much more art than science is involved. Accounting is replete with procedures which must be modified to fit particular problems. In fact accounting theorists in seminar discussions have difficulty finding anything in accounting theory which fits the definition of a principle as being "a settled rule of action, a governing law of conduct." Nevertheless, what accountants have done and must do is to apply their knowledge and intelligence to problems as they arise and, through considered opinion, determine what appear to be the most satisfactory solutions.

Solving the Allocation Difficulties

This must be the approach with respect to the problem of distributing total investment. General as well as specific bases and procedures must be developed as to how this asset or that inventory can best be considered the investment of a particular product. The intent of the description contained in this and succeeding sections of the article is to outline certain of these procedures which have been developed and are in use. The ultimate objective of the investment distribution analysis is the computation of a monthly return on investment for each product sold.

Naturally, to compute individual product investment returns, the company's income statement must be detailed as to income realized from each product. To the extent possible, all revenues and costs should be assigned to products. Investment must likewise be so distributed. This means that definite product codes must be established to properly classify each sales and cost item. However, for certain items, such as dividends received and interest expense, which bear no particular relationship to any product, it is impracticable and meaningless to make distributions. These items will be used in computing return on total company investment only.

Still, unallocated charges and credits should be kept to an absolute minimum. Even such marginal items as fundamental research, management costs, and gain or loss on sale of equipment should be distributed to products. Although this may appear to be somewhat extreme and asking for a lot of detail, it will be found that, once individuals realize assets are to be allocated to products with the fewest exceptions possible, they will think in such terms and devise distribution bases for the items as they occur. Also, the feared detail does not necessarily eventuate inasmuch as, with experience, it soon becomes obvious how certain costs and investments should be distributed.

Thus, when it comes to the actual distribution of investment, there are a lot fewer items needing decisions as to their correct disposition than would be expected. For one thing, the number of transactions in a month involving investment are much less than are those for cost. Also the distribution of cost associated with any investment journalization must be handled first and this often indicates the distribution of the investment, eliminating many separate decisions. For example, if a piece of machinery is purchased from which several products will be manufactured, some decision must be made as to how the depreciation, taxes, and property insurance costs connected with the machinery should be allocated. The distribution basis used for these costs will apply to the investment distribution made later. This type of situation holds true for most investment distributions, which considerably reduces the task of determining how much of each investment belongs to what product.

To avoid becoming fascinated with exactness and to place some form of restriction on the amount of detail to be involved in using any of the allocation bases, it is possible to use predetermined distribution percentages, reviewing them periodically, perhaps annually. Conceivably, for example, the product output of a certain building or from a specific piece of equipment might vary from month to month so that, logically, it would appear that the equipment investment should be allocated to the various products manufactured each month on the basis of their respective productions. Brief consideration of such a pro-

cedure soon indicates the maze of detail which would be encountered each month if it were used, particularly if there were many products going through several operations. The computations involved would be overwhelming and the job would probably get done far too late to be of value.

Besides that, perhaps the production basis is not the best. Maybe the asset should be allocated on the basis of the purpose of its original construction or purchase, which was probably to produce so many units or pounds of each product. A solution in such instances is to establish predetermined percentages annually, based on past performances modified for changes expected, and to use these percentages until there is some basic change, such as the production of a new product from existing equipment.

It must be recognized that it will be the larger companies manufacturing many products at possibly several plants, which will have most of the investment distribution difficulties. Offsetting this possibility, though, is the likelihood that larger companies will, for other reasons, keep much more detail regarding fixed assets, detail which, if it does not already include the point at which the assets are used, can be modified to do so. Likewise, tabulating (or even more advanced) equipment will probably be in use, which can be programmed to give a break-down of the accounts receivable balances or of sales by products, as well as to indicate the finished inventory investment in each product.

Allocating Current Assets to Products

To the extent practicable, each current asset should be identified with the products responsible for its existence. To streamline such distributions as much as possible, some of the current assets may be grouped and one allocation made of their total. For example, separate distributions will be made only for cash, notes and accounts receivable, raw materials, finished goods and deferred charges, this last-named category being the classification used for the smaller current asset accounts which would be grouped.

Probably the allocation of company cash to products is one of the most difficult of the investment distributions to be made and is typical of the items which an accountant has in mind when he thinks of the allocation of investment to products as being the creation of just so much extra controversial detail. However, even in the case of distributing as uncertain an item as cash, it is possible to develop a reasonable distribution base. For example, one method for determining the cash requirements of a product is to use its manufacturing cost less any noncash items such as depreciation. When this procedure is used, cash allocated to a product might represent one month's production cost, less any

depreciation charges. Inasmuch as cash must be available prior to any manufacturing, it may often be regarded as both appropriate and advisable to allocate cash on a forecast basis, using estimated manufacturing costs and revising the allocation only as a new budget is prepared. Adoption of this procedure further reduces some of the distribution details and difficulties. Any cash not distributed would remain unallocated and would be used in computing total company return only.

There is the possibility, as already suggested, of programming the company's tabulating equipment to yield a breakdown of the total accounts receivable balance by products. However, the most practicable method of distributing accounts receivable is to use sales or, better, still the credit sales of the various products. The adequacy of the sales distribution basis depends on existing circumstances, such as whether all products were sold to the same type of customer at the same discount terms. Modifications to the basis would have to be introduced as corrections appeared necessary.

The distribution to products of month-end raw material investments can be a simple or complicated matter, depending on whether or not the same type of material is used in the manufacture of several products. Differing materials provide a ready segregation. However, the worst can usually be expected, in that the reason for manufacturing several products is that they are related in some respect, most frequently that they originate from the same raw materials. The most obvious method of determining what raw material investment belongs to what product, for instances in which the material is jointly used, is to make the distribution on the basis of material consumed during the period just completed. As this can become a most time-consuming activity at an inconvenient time of the month, it is often worthwhile to develop consumption patterns in terms of percentages, on the basis of annual consumption figures, and to use these percentages each month, making necessary revision only once a year.

Probably the most definite and least arbitrary of all investment distributions is that which can be made of the finished goods inventory investment. In most instances there will be exact information available as to how much of each type of finished product is on hand at the close of the month. This data must ordinarily be kept "on tap" to be certain that customer requirements can be fulfilled and, vice-versa, to avoid overstocking.

Just how other current assets should be distributed is not as easily envisioned. A general rule that keeps "popping up" whenever any such investment is being distributed, is that, if there appears to be no one obvious distribution basis available, the asset concerned should be allocated among products by using a ratio of investment charged them in distributions up to that point. This method

has certain justifications, although they are not always theoretically obvious. In instances in which the existence of a particular current asset is attributable to a particular product it should be charged directly to that product.

An important point to be noted regarding the distribution of miscellaneous investment items is that, in most cases, the items involved will be but a fraction of total company investment so that any detailed or refined distribution will, to all intents and purposes, be of little significance. Nevertheless, the most meaningful and practical basis should be used in all such instances.

Fixed Asset Product Allocation Is Fundamental

It is with respect to investments in fixed assets that additional careful consideration must be given all bases used for their distribution to products, for, normally, the greater part of a company's investment will be in such assets as land, buildings, machinery and equipment. If the computation of investment returns for products is to be managerially useful, this segment of total investment must be properly handled.

The obvious place to start in the distribution of fixed assets to products is with their original purchase. When the initial investment is made in a piece of equipment, there are definite ideas as to how it will be used. Statements will have been made as to what products will be manufactured from the equipment. These specified intentions should be made part of the basis used for distributing the investment, once it has taken place. As production indicates how the equipment is actually being utilized, there will, of necessity, have to be modifications from year to year in the allocation factors used. This approach to fixed assets distribution has been found to be most satisfactory.

There is no point denying that much clerical work is necessary if the fixed asset investment is to be correctly distributed. Each building, machine, and piece of equipment must be assigned a specific number as it is purchased and put into use. Then, each fixed asset so identified must be assigned to the various products using it. The percentage distribution factors established for this purpose must be based on a review by operating personnel of how the facilities are actually used. Periodically (at least once a year), these percentages should be reconsidered with reference to past experience and changed wherever necessary.

The allocation of capital *invested* in general or service facilities such as the powerhouse, the hospital, the machine shop, and the plant laboratory, which have to be distributed to the products, present some difficulties. None of them are exceptionally serious, for, once again, the associated *costs* of these services

will already have been prorated to products so that, in most cases, investment will follow the same pattern. For example, the investment in the powerhouse will have been broken down into that used for producing steam, electricity, and water, respectively, so that each investment segment will be distributed on the basis of pounds of steam used, kilowatts of electricity taken and gallons of water consumed by each product. This is how total powerhouse cost can be distributed. Hospital investment can be distributed to each product, using the number of employees concerned in the manufacture of each. Every overhead or general facility must be so distributed, in order to determine total investment used by each product.

For a Complete Job

As much detailed discussion has been included here as is felt necessary to point out why and how investment should be allocated to products. Specific recommendations have been made as to methods which can be used for distributing various asset investments. Distribution problems often visualized as defying solution have been indicated as practically soluble. Many details, however, have been omitted. What is to be done about allowances for doubtful accounts and for depreciation? Is any special consideration to be given to current and fixed liabilities? What interpretation is to be given to the investment return computed? Each of these questions, and many others, must and can be properly resolved into a body of usable, consistent investment distribution procedures, if accountants will make it their business to achieve this.

The accountant must nourish an investment consciousness, not only on his own part but also on the part of all individuals within the company who are directly concerned with earning a proper return on funds entrusted to them. This return-on-investment consciousness embraces not only the computation of investment returns for all products sold but extends to thinking along similar lines when it comes to budgeting, justification of fixed asset expenditures, establishment of selling prices, and decisions as to whether a product should be manufactured or discontinued. To consider any product with respect to its cost or income alone is only doing half the job. Any financial analysis, to be complete, must also include an equally exhaustive study of all the investment factors involved.

Departmentalization of Return-on-Investment

by OTAKAR KUTVIRT

Staff Assistant to the Comptroller, Kodak Park Works, Eastman Kodak Co., Rochester, N. Y.

Often when the difficulties of calculating return on investment for company segments (plants, divisions, product lines, departments, etc.) are considered, attention is given mainly to troublesome points in allocating costs and assets. The present author, on the other hand—having the existence of nonproductive departments in mind, gives principal attention to allocation of sales to all departments and proposes a device based on calculations for a selected base year to provide sound and simple application for succeeding years.

THE RETURN ON INVESTMENT as an indispensable tool of modern managerial decision-making is fully established. It shows, in one rate, the result of interaction of the three all-important business factors—income, expenditure, and investment. Yet, as it is currently used, this information, in most instances, belongs to the category of historical data and is of little practical value to management in the execution of its functions. An attempt is made here to show that this drawback can be overcome by calculating the return in a departmental (step-level) fashion. This approach permits the determination of return ratios for each unit or group of units in a company. It thus acknowledges that each department is entitled to some credit for its contribution to the finished product jointly produced or to the profit realized from the sale of such product. It enables management to focus its attention on the less-than-fully-efficient spots. Finally, this approach can greatly assist management in making capital investment decisions.

Current Practice Fails to Develop Useful Ratios

Let's consider any one of our large corporations having a number of plants, each subdivided into divisions with sales and administration offices, warehouses and other facilities scattered all over the country. Every one of these units has its impact—positive or negative—on the company's total return on investment. In order to arrive at a plant's rate of return, it is necessary to allocate to it a share of assets and expenditures of a host of "outside" units. No matter what basis one chooses, whether it is sales dollars, labor cost, or some composite index of activities, it is, by its very nature, arbitrary. It never can satisfy the management of the plant concerned, which has no control of either the allo-

cated assets or allocated expenses. Plant managements are thus made responsible for the rates of return, the calculation of which is influenced—to a considerable degree—by a rule-of-thumb allocation of general assets and expense, subsidiary companies' assets, inventories and expense, finished goods inventories, accounts receivable, etc.

The problem becomes even more involved in cases in which the plants are subdivided into divisions, each engaged in turning out a different line of product. If top management is interested—as it should be—in return on investment by product lines, it is first necessary to allocate to each line (division) its share of "outside" assets and expenditures. The next step is to allocate the plant's facilities used jointly by two or more product lines. This is not an easy task. How is one to divide among the various product lines the assets of the power plant, the utilities, recreational and medical facilities, research department, general offices and similar units? Accountants charged with the responsibility of allocating these assets and expenses to the product lines involved, find the job both time consuming and overwhelming.

Further, when under present practice, the job is completed and the ratios for the several product lines are submitted to top management, this information, disclosed in typical form in Exhibit 1 (which, however, serves later in this article in approaching the departmental allocation to be described, which is predicated on a base year), is of no great value. Each rate represents the result of activities of a host of direct production departments, auxiliary departments, and of parts of other "account numbers" (plant's general departments, subsidiary companies, company's general departments, etc.). It is next to impossible, without a comprehensive study, to determine which component of the company—be it plant or product line—shows the most favorable relationship between assets, expenditures and its share of total income and which of these three factors most influenced the final result. Is the low rate of return to be explained by the activities of one or all of the direct departments, the plant's general accounts or the headquarters? Without this detailed information, management cannot be expected to suggest corrective steps for the future. The performance of all participants is hidden behind a cloak of anonymity.

This, however, unnecessarily limits the use of a valuable tool. If return on investment is an accepted measure of past performance, management's investment decisions should also be influenced by the estimated future balance among assets, sales and expenditures. In particular, one of the most essential functions of management is to pass judgment on the worth of various capital projects submitted for approval. These commonly differ greatly as to purpose. Some aim at increased sales of established products, some at sales of new products,

BASE YEAR (1950) RETURN ON INVESTMENT FOR COMPANY AS A WHOLE AND PRINCIPAL PRODUCT LINES
(In Thousands of Dollars)

	Assets	Sales	Cost	Profit	Return on Investment
Company "A"	$131,000	$108,700	$87,300	$21,400	16.3%
By Product Lines:					
1st	41,500	41,650	29,200	12,450	30%
2nd	89,500	67,050	58,100	8,950	10%

EXHIBIT 1

some at reduction in manufacturing costs. These three groups are justified on the basis of sales value added or cost items reduced, i.e., they promise to increase the firm's total profits. On the other hand, any company is likely to spend considerable amounts of money on projects (quality, safety, public relations, etc.), the effect of which on income or cost is difficult, if not impossible, to measure. However, no matter what the justification for capital expenditure proposals is, they all have one thing in common. They affect the company's return on investment either through assets, cost, income or through all of these factors. In approving or disapproving capital proposals, management should be enabled to consider the effect each is bound to have on the return ratio.

In its present stage of development, return on investment is far from being applicable to all individual proposals that one may encounter in any major industrial enterprise. It can be used only to judge the merits of straightforward cost reduction projects where the cost of investment and the benefits (i.e., savings) can be estimated and expressed in terms of a common denominator. In these cases the calculated rate of return states the desirability of the project both in absolute and relative terms. Unfortunately, such simple cost reduction projects represent a minority of new investments. Managements must deal with a multitude of projects justified by all kinds of financial and intangible returns. The mechanical application of the rate-of-return approach to these individual cases has many practical difficulties.

How can one estimate the dollar value of projects for which quality, safety, state law, or employee relations are claimed as primary justification? How to treat capacity projects that have safety as their secondary justification? Even the projects that are solely justified by capacity reasons are not necessarily easy to handle. If such a project pertains to one single operation, how is it possible to allocate to it a share of income jointly produced by hundreds of operations?

What part of "other assets" and "other expense" should we assign to it so that it may be placed on a basis comparable with the existing facilities? Under such circumstances, how can one evaluate proposals objectively and arrange, in a ladder of preference, all the various capacity, cost reduction, quality, and general projects? And how meaningful to management is a long list of unrelated projects arranged by priorities? Management has no way of detecting possible alternatives in such a list, because it cannot visualize the effects of these proposals except, perhaps, in terms of overall return ratios by company or by product lines.

What the Departmental Return-on-Investment Approach Is

These problems, inherent to the present use of return on investment in large industrial enterprises, are avoided by calculating the return by departments or other company units, such as product lines, presupposing the existence of the following data for each unit concerned: assets, expense and share of sales dollars. This approach does not, therefore, require any fundamental internal policy changes. It is singularly free from complicated accounting procedures.

The departmental basis used will obviously vary from enterprise to enterprise. Illustration of typical intra-company units in a multi-plant and multi-product company is shown as Exhibit 2. In this case return ratios may be calculated for: (1) individual production departments, (2) the division's auxiliary departments, (3) divisions or product lines, (4) the plant's general department, (5) plants, (6) the company's general departments and, finally, (7) the company as a whole. The decision as to the units or levels for which ratios are to be developed depends on the availability of pertinent data, the need for detailed information, and the type of organizational structure. This approach can be tailored to suit each company's specific requirements, but it is not desirable to bring the calculations down to small departments or workshops. Generally speaking, only units or groups of units, the heads of which have some degree of control over their investment, inventories, and expenditures, should be considered.

Solving the Problem of Allocating Sales Dollars to Departments

The only set of data not ordinarily available for the departmental calculation of return on investment in an industrial concern is the income of the various units concerned. The allocation of sales to individual departments is presently being attempted in many different ways. All seem to accept the premise that

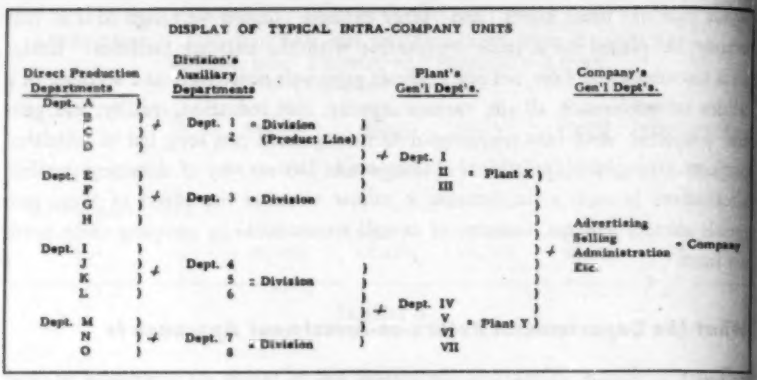


EXHIBIT 2

a multitude of interdepartmental transactions can be handled on a competitive price basis. Though these methods can be useful in some instances, they fall short of an answer to the problem involved in investment return calculations. The assumption that a competitive price exists or can be constructed for a product as it moves through the stages of production is unrealistic. It leads to arbitrary pricing, which makes any comparison among the several departments of no particular value except, possibly, to indicate a general trend. Moreover, since, under the foregoing method, all the profits are assigned to direct production departments, the other units are, by inference, regarded as having no bearing on the profit or loss of the company. Consequently, the direct production departments are apt to show misleadingly high rates of return, which are reduced considerably on the company level by addition of fixed and other assets of the non-production units. The yearly repricing of hundreds of items or the application of price index numbers also makes the procedures cumbersome and time consuming without the benefit of increased accuracy.

For most companies, it would be far more advantageous to break down the sales dollar by a method based on the assumption that, in a given base year, the assets of all departments participating—directly or indirectly—in the production and sales of a product have contributed to the joint return on investment in an equal manner. If the base year is properly selected, this assumption should not be far from real. Under normal circumstances, one must expect that all units are pulling the same rope and doing their best to assure the company of as high a rate of return as possible. By the same token, if the company's overall return on investment may properly be obtained by dividing total assets into total net profits, then all assets are in fact regarded as productive whether

they—accounting or organization wise—belong to one department (foundry) or another (general administration).

If this principle of equal productivity of all assets in a given, normal year is adopted, the distribution of sales dollars is a simple matter. The company's overall rate of return is applied to the assets of the individual departments involved for the base year thus permitting the determination of each department's share of profit. The department's share of profit added to its cost or expense will represent its share of sales. Obviously, the sum of the shares of sales of all departments will be the same as total company sales, just as the shares of profit must add up to the company's total. Once the breakdown of sales by departments is so established, the same predetermined ratios (per cents of total sales assigned to each unit in the base year) can be applied to total sales in any subsequent year. With the expense and assets figures available by departments, the calculation of departmental returns on investment can be done easily.

For companies engaged in multi-product activities, an important refinement of the recommended method can be obtained if the breakdown of sales dollars is done by product lines or by product groups within a product line. The number of ratios used obviously increases but so does the accuracy of sales dollar allocations. How far down the line a company should go depends on the availability of detailed expense and assets data and on the similarity of standard conditions of production for various products. All related products (i.e., those which are handled in a similar fashion at each stage of production) can be covered by one ratio.

Exhibits 3, 4, and 5 illustrate the outlined procedure. They are developed from the figures in Exhibit 1, already mentioned in another connection. The two tables in Exhibit 3 show the allocation of sales—by product lines—to individual units in the base year, 1950. The overall return on investment (calculated in the conventional fashion) of the first product line is 30 per cent and, for the second product line 10 per cent. In this hypothetical illustration, 25 per cent of the total assets and expenditures of the plant's and company's general departments are assigned to the first production line and 75 per cent to the second line. The 30 per cent and 10 per cent returns on investment determine the profit of each direct divisional unit for the base year. Since in that year, 25 per cent of general departments' assets are assigned to the first line, the 30 per cent return on investment will be applied only to the 25 per cent of its assets. The remaining 75 per cent of the general departments' assets will be credited with 10 per cent return (i.e., return ratio of the second line). The profit added to each unit's costs will give its share of sales. The last step is to calculate, for each unit, its per cent share of total sales of the product line as shown under

SPREAD OF SALES TO DEPARTMENTS IN BASE YEAR (1950) AND DETERMINATION OF DEPARTMENTAL SALES PERCENTAGES FOR INVESTMENT RETURN COMPUTATIONS OF SUB SEQUENT YEARS
(Figures in Thousands of Dollars)

First Product Line

Unit	Assets	Profit	Cost	Sales	Return on Investment	% of Total Sales
Dept. A'	$ 5,000	$ 1,500	$ 1,700	$ 3,200	30%	7.8%
B	4,000	1,200	1,300	2,500	30%	6. %
C	11,000	3,300	6,200	9,500	30%	22.8%
D	4,000	1,200	4,000	5,200	30%	12.5%
Total Prod. Depts.	24,000	7,200	13,200	20,400	30%	
Dept. 1	4,000	1,200	3,500	4,700	30%	11.3%
2	1,000	300	600	900	30%	2.1%
Total Division	29,000	8,700	17,300	26,000	30%	
*Dept. I	5,000	1,500	4,000	5,500	30%	13.2%
* II	1,000	300	500	800	30%	1.9%
* III	500	150	400	550	30%	1.3%
*Company's Gen'l Depts.	6,000	1,800	7,000	8,800	30%	21.1%
Total - 1st Product Line	$41,500	$12,450	$29,200	$41,650	30%	100. %

*25% of total assets and costs assigned to the first product line.

Second Product Line

Dept. E	$12,000	$ 1,200	$ 3,000	$ 4,200	10%	6.3%
F	8,000	800	2,400	3,200	10%	4.8%
G	21,000	2,100	9,000	11,100	10%	16.5%
H	5,000	500	4,000	4,500	10%	6.7%
Total Prod. Depts.	46,000	4,600	18,400	23,000	10%	
Dept. 3	6,000	600	4,000	4,600	10%	6.9%
Total Division	52,000	5,200	22,400	27,600	10%	
*Dept. I	15,000	1,500	12,000	13,500	10%	20.1%
* II	3,000	300	1,500	1,800	10%	2.7%
* III	1,500	150	1,200	1,350	10%	2. %
*Company's Gen'l Depts.	18,000	1,800	21,000	22,800	10%	34. %
Total - 2nd Product Line	$89,500	$ 8,950	$58,100	$67,050	10%	100. %

*75% of total assets and costs assigned to the second product line.

EXHIBIT 3

RETURN ON INVESTMENT (BASE YEAR 1950) ATTRIBUTABLE TO VARIOUS COMPANY LEVELS AND UNITS

	Assets	Profit	Cost	Sales	Return on Investment
1st Division	$ 29,000	$ 8,700	$17,300	$ 26,000	30%
2nd Division	52,000	5,200	22,400	27,600	10%
Plant's Gen'l Dept.	26,000	3,900	19,600	23,500	15%
Plant X	107,000	17,800	59,300	77,100	16.6%
Advertising Selling Administration	24,000	3,600	28,000	31,600	15%
Company Total	$131,000	$21,400	$87,300	$108,700	16.3%

EXHIBIT 4

"% of total sales." The table in Exhibit 4 shows an abbreviated presentation of the company's return on investment by divisions (direct and auxiliary departments combined), plant's general departments, Plant X, company's general departments and the company as a whole. A breakdown by individual departments could easily be constructed.

Exhibit 5 contains the data necessary for the calculation of 1951 return on investment by individual units as well as comparison of return ratios for 1950 and 1951. The 1951 total assets, sales and costs are assumed to be higher (in various proportions) than in 1950. First, the 1951 sales ($45,000,000 for the first product line and $80,000,000 for the second line) are distributed among the participating units with the help of the predetermined ratios developed as "% of total sales" and already shown in Exhibit 3. With the assets and costs known by the departments, it is possible to calculate their profits and return ratios.

As simple as this method is, it may require some adjustments. Any year-to-year fluctuation in work-in-process will call for more or less profit assigned to the department involved to reflect the relationship of its performance to the total sales. This adjustment may be superfluous when such yearly fluctuations are a normal way of doing business and, therefore, tend to offset one another over a longer period of time. Still another reason for occasional adjustment may be a change in the production sequence. When the production process skips one of

RETURN ON INVESTMENT --1950 (BASE) AND 1951 (COMPUTED)

(In Thousands of Dollars)

	1950	1951				
	Return on Investment	Assets	Sales	Cost	Profit	Return on Investment
Dept. A	30%	$ 5,500	$ 3,510	$ 2,000	$ 1,510	27.4%
B	30%	4,100	2,700	1,400	1,300	31.7%
C	30%	12,500	10,260	6,600	3,660	29.3%
D	30%	4,000	5,625	4,300	1,325	33.1%
Dept. 1	30%	5,800	5,085	3,900	1,185	20.4%
2	30%	1,200	945	800	145	12.1%
1st Division	30%	33,100	28,125	19,000	9,125	27.5%
Dept. E	10%	12,400	5,040	3,400	1,640	13.2%
F	10%	8,200	3,840	2,700	1,140	13.9%
G	10%	22,000	13,200	9,800	3,400	15.4%
H	10%	5,700	5,360	4,200	1,160	20.3%
Dept. 3	10%	7,100	5,520	4,700	820	11.5%
2nd Division	10%	55,400	32,960	24,800	8,160	14.7%
Dept. I	15%	26,000	5,940 16,080	21,100	920	3.5%
II	15%	8,000	855 2,160	2,400	615	7.7%
III	15%	3,000	585 1,600	2,100	85	2.8%
Plant X	16.6%	125,500	88,305	69,400	18,905	15.1%
Company's Gen'l Departments	15%	31,000	9,495 27,200	35,000	1,695	5.5%
Total - Company "A"	16.3%	$156,500	$125,000	$104,400	$20,600	13.1%

EXHIBIT 5

the formerly participating departments or includes a new one, it is necessary to re-work the established ratios. This occurs rather infrequently, yet it should not pass unnoticed here. However, changes in production methods which have taken place within a department constitute no reason for changing the ratios. Such effects will (and should) be reflected, for better or worse, in the department's rate of return.

Advantages of the Departmental Approach

The approach which has been described should overcome most of the objections which exist against the use of return on investment as either a measure of past performance or a guide to future investment decision. As a measure of past

accomplishment, the return ratio becomes a highly important tool, enabling top management to concentrate its attention on the part of the organization which needs it most. The company is divided into units along the lines of personal responsibilities and the influence of each unit's activities on the overall company picture is isolated for study. This provides answers (which cannot be obtained by using conventional methods) to questions like: "Are we deploying—on every level—the stockholders' money to its most useful purpose?" or, "From what sources did the forces generate which affected this year's rate of return as compared with last year's?"

Once the point of interest has been located, the reason for it can be discovered too. Is it the ratio between sales and investment (turnover) or between profits and sales (profit margin) or both? Additional special studies (capacity, inventory, etc.) may then be initiated to explain the cause. Thus, the responsibility for the overall rate of return is brought down to the level of management having full control over the component ingredients, investment and expense and which, as a part of a team, jointly carry the responsibility for sales. The return on invested capital becomes a measure of performance of company executives.

The usefulness of this approach is enhanced by the fact that the premises underlying it can hardly be disputed. The assets and expenses of the respective company units are known beyond any doubt. The allocation of sales dollars is based on total actual sales rather than on fictitious or arbitrary sales figures. Even the method of allocating the sales seems acceptable to all concerned, since it assumes the equality of assets' productivity of all units in the base year. The changes in subsequent years' return ratios will be the result of investment or operating policies of each unit involved.

As a guide to investment decisions, too, the departmental approach is to be preferred to the conventional method of objective evaluation of some capital proposals and subjective evaluation of others. This approach permits a ready determination of the effect of all proposed projects on each unit's rate of return. Therefore, it will make it possible for management to implement the objectives for the company as whole by setting specific objectives for each plant or division. The coordination of individual unit plans and estimates into an overall picture will be facilitated. Morover, since almost every company must ration its investment funds, management will be in a better position to direct the funds into channels doing the most good. Finally, by localizing the effects of the various capital projects, this approach leads to the consideration of possible alternatives and to the striking of a proper balance between "profit" and "non-profit" proposals.

Clarifying Return-on-Investment Determination

by W. G. LIVINGSTON

Staff Assistant to the Vice-President of Finance of The Chemstrand Corp., Decatur, Alabama

When the productive plant of a company is expanded—as when a child grows—there arise problems related to the growth itself and, in addition, problems related to the integration of this growth with previous development. Starting with identification and definition of terms with respect to formulas (and their elements) relating to return on investment, the author proceeds to tested methods—and relevant observations on them—which incorporate in return calculations many considerations of central importance to the company.

SUCCESS OF THE RETURN on investment concept in reporting and analysis of operating results is due as much to the educating of the accountant as it is to the enlightening of the manager. Accountants have begun to talk in a language already familiar to the manager and have given it more meaning through better understanding of profits and capital. The accountant has helped his company move closer to the optimum balance of price, volume, investment, and cost—factors which are all interrelated in their effect upon the profits of the business. Return on investment, as an index of profitability, sets them in focus, gives them depth and perspective. The most common uses of this index—but not all equally familiar—are in:

1. Analysis of stockholders' return on equity in the business.
2. Analysis of profits of operating divisions.
3. Analysis of profits by product lines.
4. Pricing of new products.
5. Analysis of major cost areas in a cost reduction program.
6. Study of product and process developments.

Management's Problem Is the Accountant's, Too

We have put the return-on-investment tool to good use in operating reports and in evaluation of price-cost-volume variables, but have we helped the manager improve upon the economic rule of thumb used in considering future expansion which requires additional capital? The manager and stockholder of a business have a common interest in the profits of the business. The manager is responsible for the use of the company's capital; the stockholder considers efficient use of capital by the management a good index of the security of his equity in the business. The management's trusteeship—how best to maximize profits—is not an easy one. The manager must strike a balance between max-

mizing the amount and the rate of profits, to insure continued success of the enterprise.

The men who gaze into the crystal ball need clarity of vision. Risks in fixed investment are proportionate to its relative size. Markets may not supply a sales volume large enough at a rate of profit high enough to cover risk. These are the manager's problems and, because of this, they are the accountant's also. It is the application of return-on-investment to future expansion that lends important stature to this operating concept.

Return on incremental investment, the emphasis of this article, adds a bi-focal lens to the glasses already in use. For it is the direction which capital additions take that determine, in large part, the ability of a company to sustain continued growth. It is the purpose of this paper to emphasize the important part that analysis of return on incremental investment has in shaping the future of a business.

Useful Ratios and Usable Terms

What do I mean by return on incremental investment? It is the answer, usually provided by rule of thumb, to the questions: How long will it take for a project involving new capital to pay for itself, i.e., how many years will it take additional earnings (additional sales, less additional cost) to return the additional investment? The return figure is usually expressed as a percentage of the investment. In accountant's language, definition is as follows:

$$\text{Incremental return on investment (\%)} = 100 \times \frac{\text{(Sales revenue added) minus (Cost added)}}{\text{Investment added}}$$

Definition of and terminology used for factors in this equation vary from company to company. For discussion here, I will use those employed by our company. These are probably representative.

Investment consists of plant investment—investment in plant buildings, machinery, and equipment and working capital. The latter, on the balance sheet, is the net balance of current assets and current liabilities. For our evaluation purposes, we simplify working capital requirements by considering only inventories and accounts receivable, assuming that cash will balance out payables.

We are fairly fussy about the terms we use to describe the basis of "return", i.e., *profits* to be related to investment. Operating profit we define as net sales revenue, less manufacturing cost of sales and selling, administrative, and research expense. To derive gross profit from operating profit on our income statement, we deduct special charges, such as financing expense, amortization, etc. Inasmuch as these special charges are not predictable in evaluation of pro-

posed projects—the method of financing not being established—we use only operating profit to indicate pre-tax profit, and operating profit less tax to indicate the approximate net profit after income taxes. In this way, our terminology in evaluation reports lines up—where possible—with terminology in our operating financial statements.

By *incremental* we mean sales revenue, cost, profit, investment added to the existing financial structure by the project. We analyze the requirements of the proposed capital addition, first by themselves and then as added to existing requirements. Economists call this marginal analysis. Analysis of the addition alone will indicate the direction that the previous total plus the addition will take. A capital addition with a higher return on its investment than exists on the existing investment, will raise the level of existing return to a higher level. The larger the size of the capital addition in comparison to the original investment and the higher the incremental return, the greater the increase in return.

Return on investment (whether existing or incremental investment) is an important ratio in all business, even if all plant equipment is rented and investment consists only of working capital. However, the more important the part investment plays in the structure of the company, the more significant is the return ratio. It is that part of the total investment returned to the company from sales each year, after deduction of all costs of sales and income taxes. Our management also finds the cash flow payout a useful related concept. We describe this as the number of years required to recover plant investment in cash from sales income, less out-of-pocket cost. To the operating profit less tax figure already identified, we add back costs which do not represent cash outlay, such as depreciation. The payout ratio is, then:

$$\text{Years to recover investment in cash return} = \frac{\text{Plant investment}}{(\text{Operating profit less tax}) \text{ plus } (\text{depreciation})}$$

The *capital turnover ratio* is also a tool, useful, largely, in assessing the size of capital and its risk. This index is the ratio of sales revenue to investment:

$$\text{Capital turnover} = \frac{\text{Sales Revenue}}{\text{Investment}}$$

Where both profit margin (net profit per cent of sales revenue) and investment are equally significant, return on investment is frequently computed as follows:

$$\text{Return on investment} = \text{Capital turnover} \times \% \text{ Profit margin}$$

or

$$\text{Return on investment} = \frac{\text{Sales revenue}}{\text{Investment}} \times \frac{\text{Sales revenue}}{\text{Net profit}}$$

To indicate the value of this method of calculating return, consider the following projects (dollar amounts in thousands):

	Sales revenue	Total investment	Net profit	Capital turnover	Profit margin	Return on investment
Project A	$200	$100	$20	2	10%	20%
Project B	$100	$100	$20	1	20%	20%

Both projects have the same investment, net profit, and return. But note that the profit margin on sales of Project B must be twice as big as for Project A to compensate for the low capital turnover. Which project indicates the higher risk? The high-markup, low-turnover project will not be as strong in a competitive market.

In addition to the indicators just given, *break even point* analysis will show at what point in its start-up phase, the new facility will begin to pay its own way. This is another useful guide for management.

INCREMENTAL INVESTMENT REQUIRED BY PROJECT A

Area	Amount			Per Unit Product
	Bldgs.	Mach. & Equip.	Total	Total
Mfg. Dept. X	$ 10	$ 200	$ 210	$.02
Y	40	5,000	5,040	.51
Z	30	600	630	.06
Total Mfg.	$ 80	$5,800	$5,880	$.59
Utility Area K	$ 5	$ 100	$ 105	$.01
L	10	100	110	.01
M	5	50	55	.01
Total Utilities	$ 20	$ 250	$ 270	$.03
Service Area D	$ --	$ 10	$ 10	$ --*
E	10	100	110	.01
F	--	5	5	.--*
Total Services	$ 10	$ 115	$ 125	$.01
Total Investment Added	$110	$6,165	$6,275	$.63

*Less Than $.01/Unit

Basis:
Direct Costs --Estimate X, Grade 2
Overhead Costs-10% of Direct
Contingency -- 5% of Overhead Plus Direct

EXHIBIT 1

INCREMENTAL MANUFACTURING COST REQUIRED BY PROJECT A

Item	Basis: Quantity	Basis: Unit Price	Cost Amount	Cost Per Unit Product
Raw Materials				
A	2,000 M Units	$ .90/unit	$1,800	$.18
B	2,400 M Units	.50/unit	1,200	.12
C	4,500 M Units	.10/unit	450	.05
Total			$3,450	$.35
Labor & Supplies				
Wages	705 People	$3,000/yr.	$2,110	$.21
Salaries	400 People	$4,000/yr.	1,600	.16
Operating Supplies	$.01/unit		100	.01
Maintenance Supplies	3% of Investment		190	.02
Total			$4,000	$.40
Fuel & Energy				
Natural Gas	20,000 MMCF	$ 2.50/MMCF	$ 50	$ --*
Electricity	10,000 MKWH	$15.00/MKWH	150	.02
Total			$ 200	$.02
Occupancy				
Insurance & Taxes	2% of Investment		$ 120	$.01
Depreciation	10% of Investment		630	.06
Total			$ 750	$.07
Total Incremental Mfg. Cost			$8,400	$.84

*Less Than $.01/unit

Source Data: _____

EXHIBIT 2

Three Kinds of Project Evaluation—and Their Use

These are the working tools of the project evaluator. How are they used and the components put together to tell the story to management? Timeliness in telling the story is important. We follow three phases of analysis:

1. Quick order-of-magnitude—initial and exploratory.
2. Followup in depth—to isolate areas for decision.
3. Project analysis—for top-management appropriation approval.

The cut of the cloth is, of course, tailored to the need (and there is considerable pulling and hauling over the garment while it's in the tailor's hands). Techniques used vary from "back of an old envelope" and slide rule, to the formal report.

Exhibits 1, 2, and 3 indicate the approximate steps taken in project evalu-

tion—the amount of detail tailored to the kind of estimate required. (All figures are hypothetical, and have no similarity to any company project.) Exhibit 1 illustrates the form in which plant investment estimates are summarized. Source data for the preliminary order-of-magnitude estimate is usually existing equipment estimates, or actual costs ratioed for capacity differentials (using a power factor or similar ratios.) The final, more precise estimate, will be based upon quotations from vendors and contractors.

When the engineering layout and equipment requirements are complete, an analysis of expected operating costs is prepared and summarized as in Exhibit 2. With the estimates of manufacturing cost and plant investment, an estimate of additional income is made and the return on incremental investment computed,

INCREMENTAL INCOME AND RETURN ESTIMATED FROM PROJECT A

		Amount	Per Unit
Gross Sales Revenue			
Product A	2,000 units @ $2.15 price	$ 4,300	
Product B	5,000 units @ $1.00 price	5,000	
Product C	3,000 units @ $ .90 price	2,700	
Total		$12,000	$1.20
Sales Deductions			
Out Freight		$ 500	
Provision for Bad Debts		50	
Total		$ 550	$ .05
Net Sales Revenue		$11,450	$1.15
Cost of Sales			
Manufacturing (Exhibit 2)		$ 8,400	
Research, Administrative, Marketing (8% Sales)		1,100	
Total		$ 9,500	$ .95
Operating Profit		$ 1,950	$ .20
Operating Profit Less (50%) Tax		$ 975	$ .10
Investment			
Plant (Exhibit 1)		$ 6,275	
Working Capital		225	
Total		$ 6,500	$ .65
Return on Incremental Investment		15%	

EXHIBIT 3

OVERALL RETURN ESTIMATED, WITH PROJECT A INCLUDED

	Increment		Total		
	Project A	Project B	Original	After A	After B
Production Capacity (MM units)	10	5	25	35	40
Sales					
Gross Revenue	$12,000	$5,000	$32,500	$44,500	$49,500
Deductions	550	50	1,500	2,050	2,100
Net Revenue	$11,450	$4,950	$31,000	$42,450	$47,400
Cost of Sales-Mfg.	$ 8,400	$4,000	$23,800	$32,200	$36,200
Overhead	1,100	500	3,250	4,350	4,850
Total	$ 9,500	$4,500	$27,050	$36,550	$41,050
Operating Profit	$ 1,950	$ 450	$ 3,950	$ 5,900	$ 6,350
Operating Profit Less Tax	$ 975	$ 225	$ 1,975	$ 2,950	$ 3,175
Investment					
Plant	$ 6,275	$2,400	$18,000	$24,275	$26,675
Working Capital	225	100	750	975	1,075
Total	$ 6,500	$2,500	$18,750	$25,250	$27,750
Return on Investment	15%	9%	10.5%	11.7%	11.4%
Average Unit Values					
Selling Price	$1.20	$1.00	$1.30	$1.27	$1.24
Mfg. Cost	.84	.80	.95	.92	.90
Investment	.65	.50	.75	.72	.70

EXHIBIT 4

as in Exhibit 3. We are, here, concerned only with the equipment, personnel, sales income, etc. to be added by the project under study. Our attention is directed entirely to an analysis of the addition, completely divorced from the whole plant. This, very briefly, outlines the general scope of the evaluation work undertaken and does not attempt to spell out the extensive preparatory work necessary for the completion of these exhibits. Suitable methods and techniques must be developed for the type of estimate needed and these must be, to some extent, peculiar to the operation under study.

Analysis of the increment alone—its added cost and the added income expected from it—is, of course, not entirely adequate in telling the story to management. The manager needs to have the facts to assess the proposed project and may well say, "The project looks fine, but what effect will it have upon the overall return?" In anticipation of that question, we prepare a summary similar to that shown in Exhibit 4. This is an income and return summary of both the project additions, i.e., Project A and Project B, and the overall situation including the additions. The purpose of this summary is to permit an analysis of trends and to set the economic picture of the project in perspective.

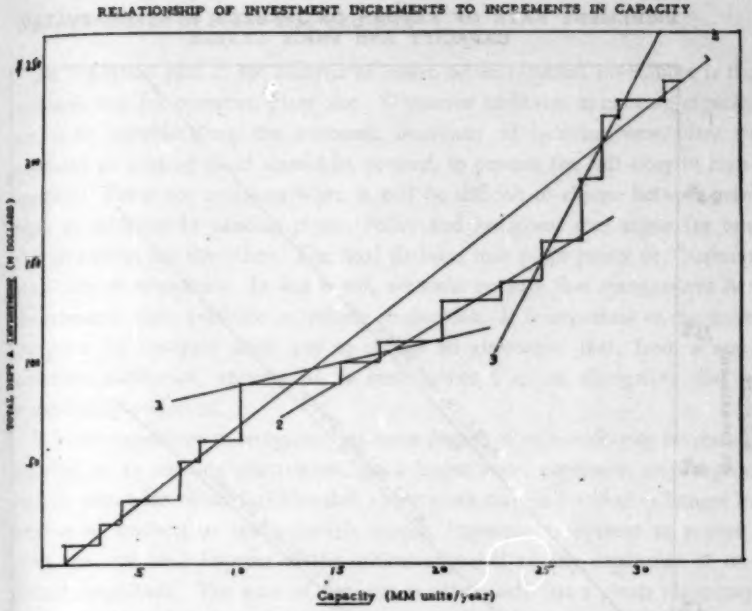


EXHIBIT 5

Where the project under consideration concerns additions to an existing plant, estimates of investment requirements beyond the capacity levels under immediate consideration are of value in determining the optumum size (investment-wise) of the proposed addition. As Exhibit 5 illustrates, the average ratio of investment to capacity over a large capacity increment range (Line 4), may well be higher (Lines 1 and 2), or lower (Line 3) than capacity increments at specific points in the range. In this chart, it is important to point out to the manager that investment increments will come more costly above a given capacity level and that definite economic optimum points do exist.

It should also be remembered that no one can assure the manager that the projected addition or plant will operate at full capacity. It certainly will run at lower-than-capacity levels during startup. Nor can we assume that market selling prices for the product to be manufactured will remain at one level. We are presenting the manager an analysis of what the future operation of the proposed project will look like on the income statement. This we cannot do with precision. However, we can, at least, attempt to assess the effect of changes in two major variables, volume and price, upon the economic picture. Exhibit 6

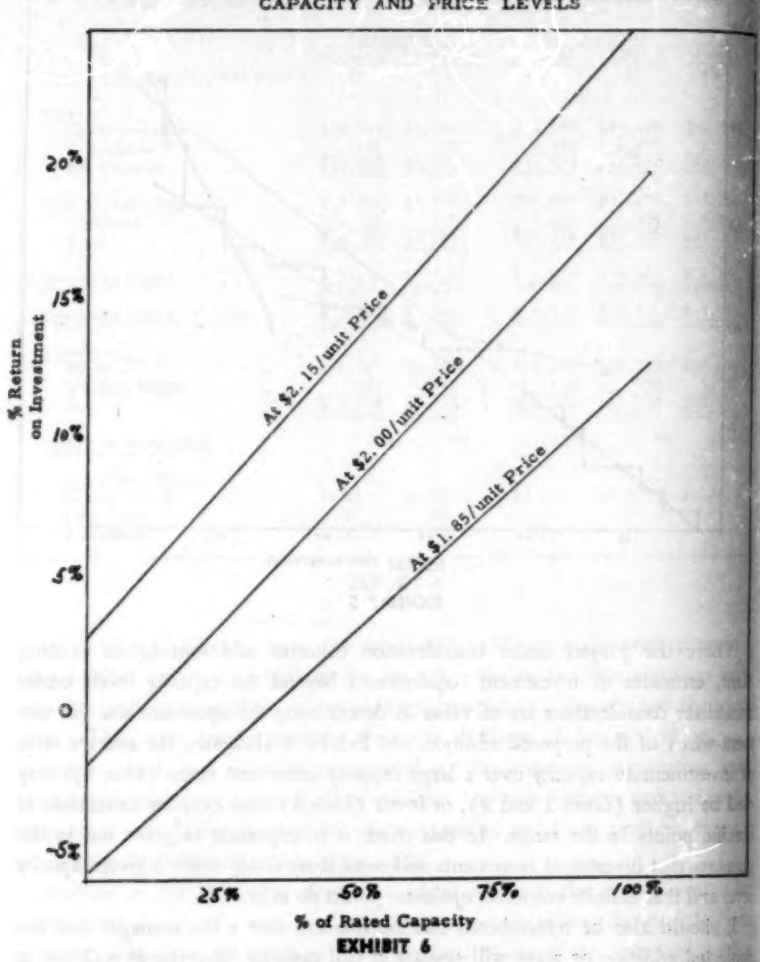


EXHIBIT 6

illustrates one method of presenting such a story. This chart shows the return on investment at four levels of rated capacity, and three levels of product selling price. The chart is based upon an analysis of the fixed and variable components of cost and a brief income statement for major points charted. This technique applies equally well to increment or overall return, to individual product or product mix.

Considerations of Plant Size and Site

An important part in the analysis of return on incremental investment is the economic test for optimum plant size. Whenever additions to existing capacity are under consideration, the economic feasibility of building new plant vs additions to existing plant should be covered, to present the full story to management. There are occasions when it will be difficult to choose between new plant or addition to existing plant. Policy and judgment may argue for one and economics for the other. The final decision may place policy or "business sense" above economics. In any event, we must be sure that management has the economic story available in making its decision. It is important to recognize the price the company must pay to choose an alternative that, from a non-economic standpoint, appears to be best, rather than an alternative that is economically preferred.

It is also important to recognize that some degree of expansion may be readily absorbed at an existing plant when, on a larger scale, expansion may require such an expansion of all facilities that a new plant may be justified. Changes in location of markets or raw materials supply, improved equipment or process, plant age—all lend impetus to the critical appraisal of any expansion of important magnitude. The pace of progress is often such that a given plant may become obsolete before completion. At this point, the return on incremental investment analysis must consider the economics of new developments and plant location.

In this connection, a close look at possible plant sites is essential in considering the desirability of building a new plant as against building an addition to existing plant. Again, the application of the return on incremental investment tool will set the various economic factors in balance. It will not compare the advantage of good schools at Location X to the advantage of good recreational facilities at Location Y. It will, however, indicate the general areas that appear to have an economic advantage and will show, as well, the magnitude of the advantage.

Test and Follow up of Evaluations

Nothing will give the cost accountant a better "feel" for the significance of his estimating techniques than testing them for the effect a given degree of error has upon the final result. Cost accountants and engineers alike are prone to smother a project evaluation with detail—and detail is rather like a warm bath—once in, it's hard to get out of it. Perhaps the job in question calls for a quick

cold shower. To test the exercise of your judgment, assume a 20 per cent error in each major variable and see for yourself what the effect upon the return on investment is in each case. This will indicate to you how detailed your analysis needs to be for each variable if it is to fit within a given error tolerance. All estimates are subject to error. It is essential to recognize that fact, determine the degree of error in major components, and assess the effect of this range of error upon the final result—return on investment.

The evaluator's education in technique will be rounded out by requiring him to check his estimates against later estimates or actual performance. The cloth of every estimate is woven with many threads of assumption. These need to be checked and brought up to date, so that analytical tools in use will be current and will meet the test of actual performance. In the three phases of analysis mentioned earlier, estimates should be up-graded at each step. In this way, the final analysis is prepared for appropriation request and top management approval will be based upon the highest quality of estimates.

Finally, a followup check of these estimates against actual conditions, when the project is in operation, will point out the degree of optimism or pessimism which were contained in the estimates. Some points to note are:

1. Were the capital estimates high?
2. Did the plant attain the yields expected?
3. Were more personnel required than estimated?
4. What do we find we actually pay for raw materials?

Answers to these questions and many others like them will help the evaluator satisfy himself that his judgment is "up to snuff" and will lend reliability to future estimates.

Limiting Factors in Return on Investment Determinations

The use of return on investment for testing the economics of capital expansion, as described above, is deceptively simple. There are a number of pitfalls which need to be emphasized if they are to be avoided. First of all, there is nothing sacred about any estimate used to probe the future. The evaluation team should be the first to recognize, state, and assess the effect of possible error upon the results. Wherever possible, the management should be furnished with the results stated as a range, rather than one figure, or with an analysis of variables, so that the men who must make the decision can exercise their judgment of probabilities. In other words, the estimates should cover the field adequately and be framed to assist the manager in exercising his judgment. (For this he will do, anyway, whether or not you feel that you have done the job for him!)

Further, no evaluation of a proposed project is complete without thoroughgoing analysis of market potentials at the earliest possible time. For important projects, this initial survey needs to be maintained on a continuing basis, to recognize changes in original expectations. A knowledge of key market factors which bear an important influence upon timing, quantity, and rate of increase to potentials, is essential. A guess of maximum potential needs to be made and then thoroughly discounted by testing the assumptions upon which the projection is based.

It is essential, also, to have clearly in mind the effect that the proposed project will have on the operating capacity of all facilities. A high incremental return may result where an addition to existing production facilities does not require additional service facilities investment (such as power, shops, warehouse space, administrative facilities.) The return picture may well be considerably different for a slightly larger increment of capacity, if a new boiler and generator and more warehouse space are necessary. Clearly, the effect of projected expansion upon present residue or surplus capacity of both production and service facilities must be thoroughly examined. For this purpose, several points in scale of expansion should be analyzed. The key points, of course, are those at which the surplus capacity of major investment components is exhausted and further investment in facilities is required. Production facilities are rarely in perfect balance. Changes in design which result in either a smaller or larger capacity "cushion" will make a considerable difference in the return on incremental investment.

It is similarly important that expansion of one particular product line be reviewed critically in the above terms. In a multi-product operation, we must be cautious in attributing return on the additional investment entirely to the product in question. A re-distribution of existing and added investment may reveal a higher return on all products (as a result of increased plant production volume) and the relative position of the particular product may not be substantially changed in the scale of return on investment. A high incremental return on investment for a particular product may be substantially different after allocation of a larger share of present investment.

The analyst must have a "feel" for potential development and improvements in existing processes. What technological changes will increase capacity, reduce cost, improve plant balance, with existing or modified equipment? An analysis of major contributions to cost may help to point the way for efforts to improve existing plant performance. He must also have a sense of timing. In any manufacturing business, time, as the most important asset, is money. The time required to develop, design, start-up, and de-bug a new process could easily eat

up all expected savings in manufacturing cost or plant investment. It may be more profitable, even, to perpetuate obsolete process and design, if time is critical to get into the market, meet competition, and assure good production performance.

In addition, obsolescence or idleness costs must be considered where new equipment replaces old. The management will want to know the cost and return level expected for the new equipment or process under normal operating circumstances. Executives will also want to know how long it will take the cost and return differential in processes to pay back any writeoff or writedown of existing capital values. The incremental return analysis, to be complete, should include this special treatment of costs and return. For the manager may decide that the additional time and risk undertaken with a new process outweigh the economic advantages, when writeoff of major existing investment is contemplated. In analysis of the economic picture, the frame is large, and the perspective broad. The canvas needs to be not just filled in but sketched with an understanding and feeling for the subject.

To Grow and Keep Growing—Soundly

Return on incremental investment is only a statistical tool. It is useful in sharpening the vision of those who must search the crystal ball and plan now for the future. As a statistical guide, it is hardly a substitute for judgment, perception, or business sense. To the extent that it provides a more enlightened basis for judgment it will be of value to the manager. The significance of this guide lies in the fact that it is concerned primarily with the future. The manager is always more interested in the future than he is in the present or the past. And, as the economists point out, it is at the margin that changes in capital and volume determine, in large part, the future course of a business. The success of a business and of its management, may well be made or lost by the increments of investment added to existing capital. For the direction these take will determine the ability of a business to grow, and keep growing.

Accounting Procedures Add Up to Service

by ROBERT C. PERRY

Division Controller, New Products Division, Corning Glass Works, Corning, N. Y.

Stressing accuracy and orderly procedure in cost accounting and directing his points in large part to nonaccounting personnel, for whom accounting information is principally developed, the author of this article describes how cost accounting—by nature a service—is related to all company activities, particularly how the information it processes is drawn from and reaches to every part of the company and aids all in planning and performance. He draws attention to the fact that this assistance, which characterizes accounting, takes a wide variety of forms and is, in one degree or another, made available at many points in the accounting process, from the collection of basic detail in quantities to (say) preparation of summary projections in dollars.

COST ACCOUNTING APPLIES the principles of accounting in such a manner that management is always assured of a detailed record, analysis, and interpretation of expenditures incurred in connection with the operation of every part of the business. These operations include the selling operation, the administration of the business, as well as the production of goods. Cost accounting is, itself, an operation, to bring to the immediate attention of management at the various levels, needs for corrective action. It does not necessarily involve money amounts. For example, cost control is exercised by knowing, perhaps hourly, what the production has been and what the standard production for that period of time should have been.

Cost accounting holds the key to all control activities and is a partner in planning. The same information which we use to determine the nature and purpose of expenditures at the factory level for material, labor, and overhead, and to measure such expenditures against some kind of formal or informal standards or yardsticks, can be analyzed in different ways according to the particular problems involved, for use in the planning of manufacturing, selling, administrative, and other operations. To do this it is necessary to determine, not only the cost of each of the various lines of products but also the cost of each of the products in a given line. Cost accounting also furnishes information regarding the costs of various operations. Without such data it is practically impossible to forecast or plan the financial position and requirements of the company. Cost planning and financial planning are parallel and related operations. They are related, too, in the pricing of inventories, particularly of finished goods,—a matter of consequence to both.

The services of cost accounting are continuous. The comprehensive need of top management for cost accounting (and the budgetary control which it implements) has become even more apparent. Modern business has become so large and so complex that it is impossible for the top executive or even the top executives of a company to keep in constant touch with all of the thousands of details affecting the operations of a business. These must be gathered, summarized, and sifted, to pass on to management, for action, the information regarding operations which fail to meet the predetermined plan or otherwise show storm signals.

Requirements for and Services of Labor Records

If cost accounting is thus an essential element in planning and control of performance by management throughout a company, it is imperative that it include the maintenance of adequate records for these purposes. Some of the records are basic and can be used for many different purposes. But there are problems. Let us consider some which arise in the collection and use of this basic accounting data required by business.

Probably the two best known sources of basic cost data are payrolls and purchased materials. The necessity for keeping track of these two costs is obvious and fundamental. As to the first, it would be impossible, in most cases, to attempt any control of labor cost or, in fact, to even prepare the payroll for individual employees unless there is basic record of production. This is always true in cases where employees are paid piece rate or bonuses based on production. Hence, the first record created in the accounting for labor cost is usually the clock card. In most of the accounting for labor costs, a three-fold purpose is served by this basic record. These three purposes are:

1. The accurate preparation of the employee's pay check and related records.
2. The distribution of the charges for labor to the work being done so that proper expense statements and cost analyses may be prepared for the guidance of management.
3. The employee's personal record of his attendance at his job. (In case of disputes regarding the violation of wage and hour laws, the clock card is accepted as the basic record by government authorities.)

If the only information necessary in the management of a business were the amount of money spent for payroll purposes, then the clock card would be the only underlying record necessary. But this information falls far short of being adequate to aid management in the control of its business. It therefore becomes necessary to use other devices, particularly some form or medium for the distribution of labor to the proper expense categories.

The form and extent of detail required for this labor distribution will depend upon the nature of the work being done. For example, an employee doing the same type of work repetitively day after day throughout the whole pay period presents the easiest kind of labor to distribute to the proper type of expense. In this category would fall clerical help, watchmen, guards and other individuals whose time is not normally charged to more than one department or operation of the company. However, a large part of the employees in many businesses must have their time properly charged to specific jobs, operations, products, departments, capital accounts, etc. This situation calls for a great deal more care in the recording of time. Several devices have been worked out to take care of this problem of distributing these labor charges, with no hard and fast rule as to which method is best. In some departments, techniques can be used which would not be satisfactory in other departments. However, the records used must meet requirements:

1. The time must be recorded accurately.
2. The information must be accurately reflected on secondary records if management decisions are to be based on it with benefit and not harm to the business.

These are reasons for the use of timekeepers for this purpose in many modern companies. It is probably the "number one" method for controlling labor distribution in use today. Another method is to have the time recorded by the employee who turns it in to a supervisor or a clerk at the end of his shift. A method which was in use for many years but which is rapidly disappearing is to have the foreman or assistant foreman of a department make a record of the time that each employee spends on each job. In modern business this is proving to be too costly a method, because it takes too much of the supervisor's time away from his primary job of supervising the operations being carried on in his department. This is a factor which is always important in devising accounting methods.

Reported labor must then be distributed, to realize objectives of collecting the information. A variety of forms may be used for this purpose. Among them are:

1. Individual job cards for each employee upon which is recorded the time spent on each individual job or product on which he has worked during the time period being accounted for.
2. Group labor distribution sheets on which the time of all employees working as a group or gang is recorded together.
3. Work orders (quite commonly used in the textile industry) made out with a series of numbered stubs attached to them. These stubs are torn off by the employee, signed and marked by him and turned in to the payroll department for processing.

Under any of these devices the time reported for each employee for each day should be checked against the clock card to determine whether or not all of the

time of the employee has been accounted for. This process confirms reliability of the data from that point on. An examination of the operations carried on by a company will reveal just how complex a problem it is to make proper distribution of labor expenditures. When we look at the number of different types of equipment, types of product, kinds of operations, etc., we can better realize the magnitude of the job. It is necessary for the management of the business to decide what amount of detail is essential to assure proper control. There are two dangers to be guarded against in making this decision:

1. An excessive amount of detail can be very costly and so unwieldy and burdensome that profitable use cannot be made of it.
2. An insufficient amount of detail will deprive management of the vantage point supplied by accounting from which to exercise proper control.

The collection and use of labor costs, therefore, must be constantly studied to assure management that a proper balance is being maintained. The manner in which labor cost data, either alone or combined with other cost information, is used emphasizes its importance. Among these uses are the following. Labor costs are usually a very important element in the total cost of performing operations or producing articles. Hence they have a very definite influence on the values set on products for inventory evaluation. They play a very important part in the setting of selling prices. When properly recorded, they highlight the operations and production methods which are responsible for large expenditures. High costs do not always indicate inefficient operations but do point to operations which should be studied.

They may be stressed for still other reasons. Payroll data at various stages are used for a number of very important purposes. An employer acts as a collecting agent for several outside organizations and some of the collections are made on the basis of a percentage of wages earned. Under Federal and, in some cases, state law, the company is required to deduct withholding taxes, and social security taxes based on the earnings and the family status of the individual. Deductions of this type and, also in many companies, deductions of union dues, are based upon the gross earnings of the individual. Hence, it is important that these earnings be accurately computed so the employee is not antagonized by the incorrect calculation of his pay. Companies also act as collecting agencies for group life, accident and health insurance, employees credit union, and for contributions made to various charitable organizations.

Payroll today is a very complicated undertaking. Its accuracy is important both within and without the company. The significance of accounting for labor costs can best be emphasized when we realize that, in a great many companies, more than half of the total cost of doing business is made up of the wages and

salaries paid to employees. Successful operation of the business depends heavily on labor cost control.

Necessary Information on Inventories and Materials Consumption

The term inventory control is rather loosely used to cover two functions which are both important but quite different. These two functions might be called accounting control and operating control and are related to each other in that they both require the maintenance of adequate records of inventory receipts and issues. Accounting control of inventories is concerned with the safeguarding of the company's property in the forms of raw materials, work in process, and semi-finished and finished products and also with proper recording of the receipt and consumption of materials and the flow of goods through the plant into finished stock and eventually to the customers. Operating control of inventories is concerned with maintaining inventories at a satisfactory level consistent with the operating requirements and the financial resources of the business. It involves record and control of material consumption. Materials of all types used in the manufacture of products involve extremely large expenditures. Without tools for control of these management cannot be assured of proper control of operations.

There are several accounting problems encountered in the proper control of inventories and of material consumption. Proper evaluation of inventories as an asset of the company, is usually related, as a practical matter, to accounting for material consumption.

The most generally used accounting procedure in determining the cost of materials and supplies consumed or sold is to deduct the value of the physical inventory at the end of the accounting period from the sum of the inventory at the beginning of the period plus the purchases received during that period. This method assumes that all of the materials and supplies which have disappeared during the operating period have either been sold or properly consumed in the production of goods. However, as the magnitude of these inventories increases, it becomes entirely unsatisfactory to rely on such an accounting method, since such a procedure does not permit a careful control of use. Cash is paid out for materials and supplies. They should be as carefully accounted for.

This problem makes it necessary to use a number of different techniques. The forms and procedures involved affect many departments other than the accounting and production departments. Customarily a department or an individual responsible for seeing that adequate quantities of certain materials and

supplies are on hand at all times has a choice of two methods. He can frequently review and study the various production schedules and determine by physical examination what materials are available and what it is necessary to purchase in order to provide sufficient materials to carry the scheduled production load. Or else he can maintain records of inventories of materials and supplies on hand. Then, using the production schedules which have been set for some periods in advance, he can determine what materials and supplies will be required to maintain that production schedule. Based upon this information, it is customary to set up maximum and minimum quantities of all materials required in order to assure that proper balance of the materials will be on hand at all times. It is desirable under this procedure to set up a materials acquisition budget which specifies the types and quantities of materials necessary and at what dates they should be purchased in order to prevent interruption in the manufacturing process.

Once the principle to be followed in maintaining proper inventory balance is decided, it is then necessary to consider the procedures which are to be used in acquiring material. The individual responsible for maintaining an adequate stock of any type of material, etc., carefully examines his inventory position and when an order point has been reached, creates a purchase requisition. This is, in effect, a notice to the purchasing department that the inventory of the particular item should be replenished. The purchasing department then issues purchase orders upon vendors notifying them that certain material is needed and advising them of the date required, the quantity, quality, etc. It is customary to send a copy of this purchase order to the individual responsible for maintaining the inventory. At the same time, a copy of the purchase order is sent to the receiving department, which is notice that certain material is on order and that preparations should be made to receive and properly store it. When the material ordered has been received, the receiving department issues receiving slips which are properly routed to both the person in charge of the inventory control and to the purchasing and accounting departments.

Imposing as the foregoing procedures and implied recording may seem to be, it is only one side of the picture. The other is that of providing for adequate information on and control of the issues of these materials and supplies. The procedure used for issuing the various materials will vary according to the nature of the materials and the purpose for which they are being used. Raw materials which are used in the making of goods are customarily controlled by consumption reports. Among the devices used are requisitions and bills of materials. A stores requisition is an order in writing, drawn on a storeskeeper and signed by a responsible individual, instructing the storeskeeper to deliver

certain materials and supplies for use. In a business in which there is a considerable amount of assembly work to be done, bills of material may be used for consumption recording. The important thing to remember about forms used for the withdrawal and consumption of materials is simply that it is essential to all concerned that they be properly filled out, showing which department is receiving the material, the quantity involved, and, by code or otherwise, the use to which the material is to be put.

Stores requisitions serve a dual purpose. First, they are the basic record which gives the storeskeeper and inventory control clerks the information they need to maintain proper records of inventories on hand. This is usually done by posting the requisitions to stores records or inventory records as a deduction from the available or physical balance on hand prior to the disbursement of that material. The other use customarily made of the requisitions is to process them for the purpose of properly allocating the material costs. This is usually done by having them properly priced and extended, and then by various means, processed to determine the amount to be charged against each account, operation, product, department, etc.

The primary responsibility for controlling the cost of materials and supplies used rests upon the individual supervisors. While it may be possible for an individual supervisor to realize very little in the way of savings in the handling and control of materials passing through his department, it should be recognized that the small amount that he may be able to save added to what might be saved by other supervisors can very quickly add up to a substantial saving to the company. It is generally recognized that a good supervisor is one who handles the elements of cost created in his department with as great care as he would in the management of his own personal business.

Development and Use of Standard Costs—Worth Time and Effort

But accounting procedures and records are not alone the spirit and substance of the detailed tasks of accounting for and controlling the broad areas of labor and material costs. They also form the tangible body of the most advanced methods of company planning and control. First, it is a well-established and fundamental principle of management that control of the activities of a business is best exercised by setting standards for each department of the organization and then checking performance against these standards and determining the reasons for the difference. To operate on any other basis in the face of the complexities of modern business would be either an impossible job or so costly that very few companies could afford it. Inasmuch as the use of standard costs

permits management to operate by the principle of exception, they have become widely accepted and used in varying degrees by many American businesses. However, their effectiveness is not automatic. It depends on the extent to which the underlying standards of performance are defined and formalized and the degree of care and thoroughness applied in their determination. Although this may vary among businesses or even among departments of the same business, it is recognized that the more diverse or complex the activities of an enterprise are, the greater necessity there is for the formalization of standards for all activities and the summarization of these standards into an integrated operating plan.

Standard costs are predetermined costs. However, not all costs prepared in advance of operations are standard costs. Standard costs should be established by a process of scientific fact finding, which utilizes both past experience and controlled experiment. The process of setting standard costs generally includes a careful selection of materials, time and motion studies of operations, and engineering study of equipment and other manufacturing facilities. When these steps have been followed in the setting of standard costs, they represent a carefully planned method of making a product or rendering a service.

It is worth while to go over this again. A cost standard is a standard of material, labor, or burden costs of any item, factor, or operation, set after careful analysis and established for the purpose of measuring and comparing results. A standard cost, then, is the cost of parts or of plant production operations determined by computation of manufacturing specifications of material, labor and burden at cost standards. This leads us to a final definition of the standard cost method, which is an accounting plan which compares actual performance with predicted performance based on computations of the standard cost of production, budgets of expense, and budgets of sales volumes, with analyses of variations from predicted results, by their causes.

In a complete application of the standard cost technique, standards are set for each element of factory cost, such as, material, direct labor, and the elements of manufacturing overhead. This involves, fundamentally, the determination of the following:

1. The standard quantity of each raw material for the given quantity of each product to be manufactured.
2. The standard price of each raw material.
3. The standard piece rate or the standard labor hours and standard hourly wage for each direct labor operation.
4. The standard burden rate or overhead cost of each factory activity, expressed in terms of dollars per unit of production, per labor hour or labor dollar, or per machine hour.
5. The standard processing routine for a given quantity of each product manufactured, i.e.

a. The standard hours for each direct labor operation.
b. The standard units of production, labor hours or dollars, or machine hours required in each center of factory activity.

This is a lot to accomplish and it must be well done. However, it is well worthwhile. In modern business, these standard costs are used as a means of high-lighting the out-of-control situations. If the standards are carefully checked and kept up to date at all times so that they reflect current operating conditions, then management is able to operate almost completely by the principle of exception. This is true of management at all levels. For example, if, in a given department, 70 per cent of the operations or products being made are produced at approximately the standard that was set for them, the supervisor in that department knows there is very little which needs to be done about that group of operations or products. He is, therefore, able to concentrate his efforts on correcting the situations which are preventing his department from attaining maximum efficiency on the other 30 per cent.

In companies in which standard costs are used, all of the supervisors should be familiar with the methods employed for compiling standard costs in their company. Knowledge of the system will give them a solid foundation for the further development and refinement of the standard costs and will enable them to achieve more effective and complete control of operations. This development or refinement is not a one-man job nor is it entirely the responsibility of the accounting department of the company. It is a job calling for cooperation between the supervisors in all departments and the accountant in constantly checking and improving the necessary basic data upon which the standard costs are set. When progress has been made in this direction, each new set of standard costs produced will be progressively better than the previous standard costs.

Budgeting Procedures Enhance the Usefulness of All the Others

Important as they are, standard costs do not stand alone as a tool of management resting largely on accounting processes and administration, yet useful throughout the company. Budgeting is another. There is a definite tie-in between standard costs and the budgets. In fact, a good budgetary system has, as a fundamental requirement, a good standard cost system. It is with these standard costs for all operations that the budget is developed and it should be pointed out that a budget is basically only as accurate as the standard costs are realistic.

Perhaps the best definition of a budget is that a budget is a co-ordinated plan for the operation of the business expressed in financial terms. Planning, involving the setting of standards, coordination of the plans for all functions of

the business and expression in terms of financial results are all essential features of budgeting for management control. There are over-all budgets and functional (segment) budgets. For example, the budgets commonly used in a manufacturing enterprise are the sales budget, manufacturing budget, the cost of manufacturing budget, the financial budget, and the profit and loss budget. Some companies break their budgets down even finer, with a labor budget, a material acquisition budget, and equipment acquisition budget, etc., each of the individual budgets being a supporting plan.

The budget usually requires, as special information, a forecast of sales and sales income. Also, a plan of production is developed to meet the requirements of this sales forecast and estimates are made of the cost of goods to be sold, the quantities and value of the inventories to be carried, the amount of raw materials to be purchased, wage rates of labor, and other factory expenditures required to meet the production schedule. The selling and distribution expenses necessary to obtain the budgeted sales and to deliver the goods to the customers are determined. In addition, the expenses of the administration, research and development, engineering, and all of the other general or corporate expenses of the business, are established for the budget period. It can readily be seen that all of these activities require a good deal of attention and must be planned in relation to each other and particularly in relation to the sales forecast. If the job is well and thoroughly done, the completed budget meets the definition of a coordinated plan for the operation of the business as a whole.

Departmental budgets likewise have their problems. The first step is to determine what portion of the production necessary to meet the sales budget is to be allocated to the particular department under consideration. When this has been determined, the supervisor of the department, together with the plant accountant, the production planning department, and the industrial or methods engineer (if such are available), review what is required in the way of materials, equipment, and personnel to deliver the desired production at the proper time. It is their job to so plan the operations that peaks and valleys in utilization of man and machine power are reduced to a minimum and that economies of runs of economic lot size may be realized, as well as reduction to a minimum of the number of change-overs and amount of nonproductive time required to obtain the desired production from the department. With the knowledge of what is required in the way of production and also with data concerning the past operations of the department, the supervisor is in a position to prepare most of the data necessary for his departmental budget. It is the job of the accountant to translate it into financial terms. It should be emphasized, however, that this must be a cooperative enterprise.

The budget report is definitely climactic to the procedure and it, too, must be well developed. It should give the supervisor of the department a detailed analysis of his actual expenses as compared with the budget allowance. It should also show the variance and should carry a variance analysis sheet listing the variances over which the supervisor has no control and detailing those for which he is responsible. Again, it is essential that the study of a period operations report should be a joint enterprise between the accountant and the supervisor. They should sit down together and discuss those items for which a variance exists and should both reckon it profitable time.

It is up to the supervisor then to relate to his superior the out-of-line operations and conditions, and indicate what corrective action should be taken. The supervisor in turn studies reports from the various department heads under him and filters through to his superiors the important data which should be brought to their attention.

This process of filtering the information works all the way up to top management where important out-of-line conditions are brought to attention and studied for the purpose of taking necessary corrective action. Were it not for this process of controlling by exceptions, it would be a very difficult matter indeed for management to work itself out of the maze of detail that would be necessary in order to control operations.

The Primacy of Cost Control

Top management of modern business believes that its most important responsibility today is the control of the cost of doing business. This includes not only the control of manufacturing costs but also the costs of the managing process, of distributing and selling products, and all other operations involving the expenditure of money. The managements of most American businesses today are more conscious of their break-even points than at any time in our industrial history. The point has been reached at which the difference between anticipated income and the cost of producing that income is so small that it represents a very narrow margin of profit. In fact, in many business enterprises a slight decrease in the volume of business would result in the company operating at a loss.

Hence it is that management of most firms believe that the primary job of line supervision, all the way down to the department foreman, is to control cost actively and aggressively. The successful supervisor is the one who does not pay lip service to the control of cost, but who constantly studies his responsibilities, the results of his operations, and the costs of performing them. He

must be constantly seeking a better and less expensive way of conducting his department's operations or to find a way of obtaining increased production for the same amount of money he is spending. Supervision at all levels can cooperate with the management of the company by thinking constantly in terms of improvement, by seeing that suggestions, either their own or that of their employees, are carefully evaluated and discussed, and that those worthy of further attention are passed along the line for action.

It should be obvious to all that each has a personal and selfish motive in the control of costs for which he is responsible, for the future security and success of the individual depends upon whether the company operates at a profit or a loss. When the company is operating at a loss, it is unlikely that it will be able to expand its operations or that salaries and wages can be increased. In fact, if continued operation at a loss is encountered, it could very well mean a reduction in the income of the employee or perhaps layoff or loss of job. On the other hand, a company which is successfully operating at a profit is in a better position to expand its markets, to grant its employees new benefits, and to maintain a high and satisfactory level of remuneration for the efforts of its employees. It can safely be said that top management looks at cost control as the primary responsibility of every loyal employee.

Cost control is the business of everyone in the company but particularly that of the foreman and supervisor who can exercise control over the largest areas of costs. However, the cost accountant must see that the information necessary for control is available. Standard costs and budgets are essential tools for cost control but, unless they are effectively used by the foreman and supervisor, the desired objectives cannot be achieved. Top management must be supported by an effective system of cost control and is dependent upon the lower echelons of management for their cooperation in seeing that control is effectively exercised.

This paper has stressed the viewpoint of the foreman and supervisor, primarily for the reason that the accountant cannot play his part in the control of costs without the enthusiastic cooperation of operating supervision. That cooperation must be built upon an understanding of the objectives to be achieved, the means to be used, the reasons for them, and how they all fit together to form a program aimed at the successful operation of the company. With such an understanding, comes the realization on the part of the supervisor that he is an important part of the management team, upon whom rests the responsibility for the achievement of successful operations, resulting in maximum profits with the minimum investment, both of which mean the continued growth and development of the company.

A Cost System for a Frozen Meals Manufacturer

by PATRICK J. McCULLAGH

Chief Accountant, Fradelis Frozen Food Corporation, Los Angeles, Calif.

A stream-lined cost system is succinctly outlined here, based on practical standards developed by operating staff and used for book entries and for cost control by cost elements. Variance analysis is performed monthly and underlies cost investigation where indicated. The paper is illustrated with key forms employed.

THE FROZEN FOOD INDUSTRY is comparatively new and, within that industry, the manufacture of pre-cooked frozen meals is of most recent origin. This article deals with a cost system put into operation on short notice to meet the demands of a rapidly growing Los Angeles firm which put its first tray dinners on the market in September, 1954, and is now the leader in its field in the West. As operations developed, there was a pressing need for detailed accurate cost information which had to be supplied at minimum cost because of the demands which growth made on working capital.

The Nature and Environment of Operations

The company processes and freezes the meals at a central plant and ships finished products to distribution centers where they are stored in refrigerated warehouses on a consignment basis. Sales are made principally to large wholesale grocery distributors—over 4,000,000 tray dinners a year, although the number of invoices issued is small. Prices are generally set by competition. The small margin of profit which even the most efficient producer enjoys is extremely vulnerable to small variations in unit costs. For this reason, reliable and timely cost information is vital. This information must show accurate manufacturing costs for each menu, accurate distribution costs for each major sales area (which are rapidly extending over the United States and its territories), and information on which to base local and general advertising budgets. Finished goods inventories must be controlled carefully to ensure freshness of product, conservation of working capital, and adequate local supplies.

The overall elements of manufacturing cost are divided in the following approximate proportions, from which, it is obvious that the control of materials and packaging is of paramount importance:

Raw material and packaging	80%
Labor	14
Factory overhead	6
TOTAL	100%

Plant production is divided into three major cost centers. They are (1) preparation of food, including all cooking; (2) assembly line, where individual meals are assembled on aluminum trays and each meal covered with an aluminum-foil overwrap preparatory to blast freezing; and (3) wrapping line, where the frozen aluminum covered meal is placed in a carton, labeled and packed in dozens in shipping containers, before being moved to the finished goods holding freezer.

Raw Material Cost Control Under Standards; Packing and Shipping

The system of material usage control was developed when experience proved that there are many practical difficulties in the way of attempting to establish written records for materials at time of issue to production. The number of items of raw materials is relatively small (under 100) and consists of three major categories:

1. The entree item (meat, fish, etc.)
2. Vegetables.
3. Other ingredients and condiments.

The company is currently producing ten different menus. Some items of raw materials are received daily: Fresh beef, eggs, butter, fresh vegetables, etc. These are held for short periods under normal refrigeration before going into production. Other items are received frozen, vegetables, etc., and are stored in freezers. Dry items—flour, canned items, etc.—are subject to normal storage.

The first step in the accumulation of cost of materials used in each menu is to establish a standard quantity of each item used per thousand meals. This information is developed by production personnel from the recipes used for each menu. These material usage figures are recorded on a Cost Reference Sheet illustrated in Exhibit 1. Quantities used are extended at a standard cost rate developed by the purchasing department to obtain a total cost per thousand meals and a unit cost per meal.

Because seasonal price fluctuations occur, material invoices are extended at the standard unit cost, as established, and are recorded in the purchase journal in the three major categories mentioned above, which are used as general ledger control accounts. At the same time, a posting is made to a Material Record Card maintained for each item, as illustrated in Exhibit 2. A complete physical inventory is taken monthly to obtain the month-end quantity of each item on hand which, when posted to the material record card, reveals by deduc-

COST REFERENCE SHEET

Menu #6_____ Date_____

Meals Produced: 1,000

Ingredient	Quantity			Cost Analysis		
	Unit	Raw	Cooked	Unit Cost	Total Cost	Cost per Meal
Beef	Lb.	400#	330#	$.48	$192.00	$.19200
Potatoes	Lb.	230#		.06	13.80	.01380
Lima Beans	Lb.	150#		.16	24.00	.02400
Butter	Lb.	11#		.66	7.26	.00726
Etc.	--	--		--	----	-----
						$.XXXX
Packaging Supplies						
	Quantity					
Aluminum Trays	1,009			$60.00 M	$ 60.54	$.06054
Aluminum Overwrap	1,013			12.00 M	12.16	.01216
Etc.	-----			------	-----	-----
						$.XXXX
Direct Labor						
Preparation						$.07134
Assembly Line						.03642
Wrapping						.02140
						$.XXXX
Total						$.XXXX

EXHIBIT 1

tion the quantities of the items consumed in manufacture. Entries to Exhibit 2 are made from the following sources:

1. Inventory — from physical month-end counts.
2. Purchases—from vendors' invoices.
3. Meals produced—from a summary of daily production reports.

The extension of standard quantity (shown on top of Exhibit 2) by meals produced gives standard consumption for each menu. The use variance for the period in question is determined in this way. Significant variances are reported to production personnel and causes are immediately traced. Attention is directed to items which show excessive usage when compared to standard usage. Improvements in processing methods frequently result.

MATERIAL RECORD CARD

Item: Lima Beans | Grade: "A" | Unit: Lb. | Standard Cost: $. 16

Standard consumption per 1,000 meals: Menu #1 - Menu #3 200# Menu #5 - Menu #7 -
Menu #2 - Menu #4 - Menu #6 150# Menu #8 -

Vendors: A. Grow Pak, Inc. B. Freeze Fresh Corp.

Received			Production		Consumption		
Date	Vendor	Quantity	Menu #	Meals	Standard	Actual	Variance
1/1	Inventory	6,500#	3	62,000	12,400		
1/5	B	30,000	6	45,000	6,750		
1/31	Total	36,500		Total	19,150	19,500	Plus 350# Jan. --
2/1	Inventory	17,000					

EXHIBIT 2

The allocation of packaging and shipping material costs to products presents a lesser problem. Invoice charges are distributed to two major categories in the purchase journal. These are (1) aluminum trays and foil overwrap and (2) cartons, labels, etc. Since packaging is similar for each meal, cost analysis of this element by each menu is not necessary. An inventory card is maintained to which all purchases and physical inventories are posted. Again, monthly physical inventories supply the data for determining consumption by deduction. Additionally, the purchase and use information on the card is used in establishing inventory levels.

A standard unit cost per meal for each item of packaging and shipping material has been determined from production experience. (Aluminum tray and foil overwrap usage are illustrated in Exhibit 1.) The quantity of items used per thousand meals produced has run slightly in excess of the corresponding number of units produced, because of wastage and other losses.

Charging Labor Costs and Developing Standards

Direct labor employees are paid on an hourly basis and are subdivided into three wage categories as follows: $1.60 or less, from $1.65 to $1.85, over $1.85, and are so grouped on payroll sheets. Production personnel supply the payroll clerk weekly with a schedule which shows the number of employees from each category assigned to each department, for example:

Wage category	Preparation	Assembly line	Wrapping	Total
A	12	35	10	57
B	3	4	3	10
C	10	2	2	14
				81

DIRECT LABOR REPORT

Preparation _____ Date: _____

Operation: Breading Veal Menu: #2 Meals Prepared: 1,830

Class of Labor	Number of Employees	Time From	Time To	Hours	Total Man Hours	Average Rate	Office Use Cost
(a)	2	8:00 am	10 am	2	4	$1.50	$ 6.00
(b)	3	8:00 am	11 am	3	9	1.75	15.75
(c)	2	10:00 am	11:30am	1 1/2	3	1.90	5.70
							$27.45
			Unit Cost of Operation Per Meal				$ .015

EXHIBIT 3

Any mid-week changes of assignment, which occur infrequently, are also reported. The total direct labor payroll is distributed to the departments by wage categories in the direct ratio to the number of employees. For example, if 35 employees from category "A", out of a total of 57, work in the assembly line department during the week, 35/57 of the direct labor in that category is distributed to that department. These groupings are used to minimize the distortion which an overall average rate might produce.

For purposes of determining the direct labor costs for each menu for the preparation department, a schedule of operations has been made out by production personnel to cover the preparation steps of each menu. Performance data for establishing standard rates for each detail operation has been collected for test periods by means of a daily Direct Labor Report, as illustrated in Exhibit 3. A summary of the various detail operations is accumulated to arrive at a total standard labor cost for preparation for each menu. One average direct labor standard rate for all menus is established for the assembly department and the wrapping department, inasmuch as all products receive similar treatment during these two operations. These standard rates are established by dividing the actual direct labor expense for test periods by the number of meals produced. A standard rate for indirect labor has been established in the ratio that indirect labor bears to direct plant labor.

Special weekly labor reports are prepared for management to show variances from standard for each department, the overall percentage of indirect labor to direct labor, and the overtime premium paid.

Factory Overhead—A Virtual Constant

A study of factory overhead has revealed that, despite widely varying volumes of production, the components of plant overhead show only minor fluctuations in amount from month to month, provided all charges are properly accrued. Repairs and maintenance and vacation pay are two exceptions. The former category includes charges incurred for the repair and maintenance of machinery and refrigerating equipment and for keeping the premises in the best possible state of repair, thus ensuring perfect conditions for proper sanitation in conformity with government health regulations. Expenditures under these headings vary considerably from month to month. The procedure adopted is to establish a yearly budget for each of these items and to charge them off at average monthly rates. A recurring journal entry is used to record monthly accruals of this element and the factory overhead account is closed monthly to work in process at actual.

Variance Development; Inventories at Standard Cost

At each month-end, production summaries are utilized to accumulate total meals produced for each menu. These are extended at standard unit costs. To determine standard labor and material for this purpose, the detailed breakdown for each menu is regrouped into summary totals as follows:

Item	Standard Unit Cost	Total units produced	Total standard materials and labor
1. Entree item	$.xxxx		$
2. Vegetables	.xxxx		
3. Other ingredients	.xxxx		
4. Trays and foil	.xxxx		
5. Packaging	.xxxx		
6. Direct labor	.xxxx		
7. Indirect labor	.xxxx		
Total	$.xxxx		$

The items are cross totaled for all menus to group totals which are credited to the applicable general ledger control accounts and charged to work in process. The inventory quantities determined from physical inventories are set up in the inventory accounts, and differences, representing use variances, are charged to appropriate variance accounts, which are a direct charge to cost of goods sold. Factory overhead, as has been explained, is cleared to work in process at actual.

MONTHLY VARIANCE SUMMARY

	Standard	Price Variance	*Use Variance	Actual
Raw Materials Consumed	$ ---	$ ---	+ $ ---	$ ---
Packaging Supplies	---	---	- ---	---
Direct Labor	---		- ---	---
Indirect Labor	---		+ ---	---
Factory Overhead	---			---
Cost of Goods Manufactured	$ ---			$ ---

*Note: Detailed analyses of variances illustrated above are prepared for management or supplementary reports.

EXHIBIT 4

The month-end inventory of work in process is recorded, and the net adjustment to the work in process account, determined by deduction, is closed to finished goods. The month-end finished goods inventory, as determined by physical counts extended at standard rates is recorded, and the resulting adjustment to the finished goods account is closed to cost of goods sold.

A special report is prepared for management summarizing variances, which are analyzed in such detail as is necessary to show causes. The form for this is given in Exhibit 4.

Control of Goods in Warehouse and of Distribution Expense

To record movement of merchandise consigned to warehouses, sets of forms similar to standard invoices have been designed and are used to record all such shipments. Lot numbers assigned by warehouses are utilized as a means to control quantities and age of each type of menu in storage. Invoices to customers are made up from warehouse release forms which indicate these lot numbers. Perpetual inventory records, posted from copies of these two basic documents, establish the desired control over finished goods, and these inventory records are checked monthly to warehouse inventory reports.

Quantity controls are also set up through the sales journal. All shipments to customers are extended at standard sales price per case. An insert page in the sales journal is used to record the number of cases of each menu sold. The figures for total cases sold in each price group, multiplied by the unit price per

case, produce the total gross sales and serve as an additional check on the accuracy of billing extensions. Beyond this, a ready record is available of the sales mix, and finished goods inventory records in quantities can be tested by adding production (by menus) to opening inventories and subtracting quantities sold. Further, the total number of cases sold is immediately available before outside inventory reports are obtained. (This enables the accounting department to calculate an estimate of cost of goods sold, to supply management promptly with reasonably reliable estimates of the overall monthly profit figure.)

A control account is used to collect all distribution expenses on finished goods. These include storage and warehousing charges, freight out, ice and refrigeration, personal property tax, and insurance expense allocated to distribution. All charges involved are those incurred in moving finished goods and storing them on a consignment basis in refrigerated warehouses. These costs are posted to a control card for each warehouse. Each month these cards are completed to show total warehouse receipts in cases, total warehouse releases in cases, inventory balances, total distribution expense, and unit expense per case sold. From these cards, a standard distribution cost per warehouse is determined. Monthly and special reports on inventory turnover and slow-moving items are based on these records.

A Galaxy of Useful Information

Besides making monthly operating statements available to management three days after the closing of the books of original entry, the system which has been described in this article provides management with accurate and timely information on:

1. The elements of cost of each menu.
2. The rate of consumption of each item of raw material, as a basis for decisions on purchasing.
3. The operating efficiency of production.
4. The status of finished inventory and sales volume by menus, as a basis for production planning.
5. Day to day sales progress.
6. The effect of changes in production volume on manufacturing costs.
7. Essential data from which ready estimates of costs can be prepared when new menus are being considered.

The system is still in the process of development, as it keeps pace with the demands of a rapidly growing concern. It has, however, achieved its primary purpose in supplying to management, at minimum cost and during a vital phase of growth, timely information essential to profitable expansion.

Accounting for Financial Control In a Professional Stock Theatre

by RICHARD C. JOHN

Administrative Advisor to Professional and Community Theatres, Milwaukee, Wisconsin

The many categories of expense besides direct expense (and the wide choice which exists among the possible levels of these expenses) may not be the first thought of stock theatre management, nor is its first thought the pitfall of prematurely using funds from advance sales of tickets. However, recognition of these considerations and many like them, may, as the present author shows, influence theatre financial control and management, to the ultimate benefit of artistic endeavor.

THE MORTALITY RATE of professional stock theatrical companies has been very high over the past twenty-five years. It is estimated by experts in the field that only one company of every twenty stays in operation for three or more seasons. Currently, however, the professional stock theatre is experiencing a rebirth of interest. The prohibitive expense of taking Broadway productions on tour has caused a famine of first-grade theatrical entertainment in other areas. The American National Theatre & Academy is currently developing plans for a circuit of forty fully-equipped professional theatres. The outstanding successes of Margo Jones' Theatre in Dallas, the Palm Beach Playhouse in Florida, the Fred Miller Theatre in Milwaukee, as well as that of hundreds of summer stock companies, attest to this growing public interest.

Why Success or Failure?

Examination of successes and failures in this field reveals that intelligent and capable management is an absolute requirement for success. Many companies have enjoyed excellent box-office business but have failed because of inadequate or inefficient management. More than in most businesses, effective accounting reports, controls, and systems are an integral part of successful theatre management. The oft-used "cash received and cash disbursed" set of accounts is completely inadequate as well as virtually meaningless.

A few observations will make this clear. Before and during the beginning weeks of a season, a company may have a very substantial amount of cash on hand from advance ticket sales. However, income is not realized until the

individual performance for which a ticket has been sold has been given. Also, a large cash balance at the end of a season may be rapidly depleted by closing expenses, unpaid bills, and between-season administrative costs. In a continuing operation, there must be enough cash to cover these costs plus the next season's preliminary expenses and trade union performance bonds (cash deposits held in escrow throughout the period of employment of union members).

Categories of Income and Expense; Record-Keeping

A professional stock company's income is earned during its season. This season consists of a consecutive series of shows, each presented for a specific period of time. For example, a twenty-week season may consist of ten shows, each running for two weeks. Income is derived, primarily, from the sale of admissions to these shows plus miscellaneous sales of merchandise and/or services to patrons.

The expenses incurred by a company may be divided into four groups. The first is that of preliminary expenses. These are the costs of preparing for a season. Tickets must be printed and sold. In accordance with union regulations and customs, roundtrip transportation must be paid to the resident acting company and staff from New York to the theatre. Advertising and publicity must be created and placed. Often, the physical plant is in need of repairs, renovation or decoration.

Closing expenses are the second category. Props, scenery, costumes, etc., must be prepared for storage. Often the actual physical closing down of a building or tent is involved. In practice, these expenses frequently may be included in the administrative group, the third group.

These administrative expenses are year around in their nature, although they may increase in amount during the season. Included are office expense, manager's salary, publicity salaries, box office salaries, and all other expenses which both precede and follow the production season. Rent, utility bills and write-offs of fixed assets would fall in the group.

The fourth, and best-known classification consists of direct production expenses. These are the expenses which can be directly charged to individual shows. Included are royalties, props, scenery, costumes, actors' salaries, directors' salaries, direct transportation, direct advertising, and publicity.

During the season, the most meaningful (and convenient) accounting unit is the individual show. Box office statements, required for tax and royalty purposes, show the paid admissions to each performance. An excellent accounting procedure, to be discussed later, is to maintain separate receipts and

disbursements records for the box-office. The sum of paid admissions plus the miscellaneous sales income constitute the income of the individual show.

To effectively apply costs against income, the books of original entry must provide for the division of expenses into the categories already described, i.e., preliminary, closing, administrative and direct show expenses. As the individual expense items is entered in the journal, it is marked with A for administrative, C for closing, P for preliminary, or with a Roman Numeral to denote an expense directly applicable to a particular show. This marking should be observed whether the operation uses a voucher register, purchase orders, and journal or only a cash disbursements journal. As the journals are footed, the expenses are broken down in summary as above.

Separate Box Office Accounting

As mentioned before, box office cash handling should be completely segregated from other accounting. In addition to ordinary controls, such as daily bank deposits for all receipts, bonded cash handlers, etc., it is desirable that a separate box office bank account and separate receipts and disbursements journals be maintained. All box office receipts should be deposited in this account, debited to box-office cash and credited to advance box office sales, a liability account, and to taxes due the Federal Government, also a liability.

After each performance (or weekly, if more convenient), the box office manager should present to the business manager a statement of paid admissions and check therefore, all unsold tickets, and all authorizations from proper authority for complimentary tickets. The sum of these must equal full capacity. (As a check, the business manager must count the house every night and supervise a count of torn ticket stubs by the ticket-takers after each performance.) Two accounting entries are made to record this transfer of funds. One is a debit to advance box office sales and a credit to box office cash. The other is a debit to operating cash and a credit to admissions income. On the closing night of the season, the box office manager should make his final settlement.

Interim Reports on Operations

Operating statements for each show are prepared in the conventional manner by adding income and deducting direct production expenses. Since preliminary expenses have already been completely incurred, the proportionate share of these is also deducted. At this point, another important phase of the accountant's work enters the picture. To give management a reasonably accurate profit pic-

OPERATING STATEMENT OF THIRD SHOW OF XYZ STOCK THEATRICAL COMPANY HAVING A 20 WEEK SEASON OF 10 SHOWS

Admissions Income after Tax:	1st Week	$15,000	
	2nd Week	17,000	$32,000
Net Miscellaneous Incomes:	1st Week	300	
	2nd Week	250	550
Total Income			$32,550
Less: Direct Expenses of Third Show			
Salaries		$10,000	
Royalties		1,500	
Costumes		500	
Props		300	
Scenery		1,500	
Electrical & Sound		500	
Advertising & Publicity		3,500	
Other Direct Expense		2,200	20,000
			$12,550
Less: One-tenth of Preliminary Expenses which totaled $10,000			1,000
			$11,550
Less:			
One-tenth of Closing Expenses (Est. at $3,000)		$ 300	
One-tenth of Administrative Expenses for year (Estimated at $30,000)		3,000	3,300
Net Profit for Third Show			$ 8,250

EXHIBIT 1

ture, a proportionate share of estimated annual administrative expenses and closing expenses must be deducted whether or not incurred. The budget conferences with the business manager and general manager and/or producer, discussed later, develop these figures. A simplified statement might appear as in Exhibit 1. At the end of the fiscal year (which should fall midway between seasons), a complete and more conventional operating statement should be made. It is the purpose of the statement in Exhibit 1, plus cash control reports, to provide management with "on-the-spot" operating information.

Schedule of Cash Availability—Key in Planning

The procedure of grouping expenses described earlier in this paper serves as the basis for management's cash planning and budgeting. As management

SCHEDULE OF CASH AVAILABILITY (ABRIDGED)

	1st period	2nd period	3rd period	etc.
Cash on Hand - 1st of Period				
plus Cash Rec'd during period (Est. 1/2 capacity)				
Total Cash Available during period				
Less: Administrative Expense				
Closing Expense				
Preliminary Expense				
Performance Bonds				
Cash Available after Fixed Chgs.				
Less: Direct Production Costs				
Cash Carry - over to Next Period (incl. Required Reserves)				

EXHIBIT 2

approaches a season, there must be adequate cash to cover all preliminary expenses, a substantial share of administrative expenses and the bulk of direct expenses of the first three or four weeks. Only as a last resort should advance ticket sale money be "borrowed" for operating expenses. To effect the necessary planning, budgets should be prepared, at the beginning of the fiscal year, for the coming year's operations. In consultation with the general manager, business manager and any other interested parties, detailed estimates of administrative, preliminary, and closing expenses may be prepared.

The figures evolving from these conferences are then spread on a time basis on the Schedule of Cash Availability, shown in Exhibit 2. By working within this schedule, management can decide what type of production it desires for each of the shows. The type of show chosen determines the direct production expense. Modern-dress, one set shows cost much less for scenery, costumes and props than do costume or period shows or those with multiple sets.

If economy is in order, the simpler show must be chosen. However, if there will be adequate money, more elaborate productions may be achieved.

This schedule is made at the beginning of the fiscal year, after the annual budgets for administrative, preliminary and closing expenses have been developed. Its purpose is to present to management an accurate picture of the cash requirements for the ensuing year. The periods represent shows, not equal time intervals. Each show constitutes one period and some shows may be budgeted to run longer than others. The interval from the beginning of the fiscal year to the beginning of the season and the interval from the end of the season to the end of the fiscal year may each constitute one period or be broken into several periods according to the needs of management.

In the schedule, the cash balance at the beginning of the fiscal year is entered in the first period as cash on hand. Assuming that the fiscal year begins one month before the opening of the season, this period is one month long. There will be no cash receipts. The opening balance is the only cash available. For budget purposes administrative expenses estimated to occur during the period and preliminary expenses are deducted from it. The remaining amount is available to cover direct production costs of the first show and required cash reserves. The schedule also provides for appropriation of the cash performance bonds.

Assuming the second period to be the first show of the season, admissions income will be added to the amount of cash on hand at the beginning of the period. Again, administrative expense is deducted. Preliminary expense should be paid for before the first show hits the boards. The estimated production costs of the first show are deducted in this second period. The cash carry-over to the third period, in a conservatively run operation, should be sufficient to cover the fixed expenses and the direct production costs of the second show plus the required cash reserves. The budget should be developed in this manner, so that the cash carry-over after the last show of the season will be large enough to cover all between-season expenses, fixed asset requirements and profit distribution to the owners.

Solvency for the Sake of Art

The limitations on the uncontrolled expression of artistic enterprise, imposed by the modern business management devices described, can lead the theatrical stock company to profit success which, in turn, will finance continuously greater artistic achievements.

Using Probability Theory for Economy in Cost Control

by ALEX L. HART

Alex L. Hart Associates, Centerport, New York

What most cost accountants suspect of statistical techniques—that they are difficult of comprehension and would be over-detailed in application—is presented here as a misconception if ultimate effects be considered. It is pointed out and exemplified that normal limits of error, if known (as they can be through application of probability statistics), also narrow the areas for investigation of variances or, to put it statistically, deviations.

THE ACCOUNTING PROFESSION has made little use of the techniques of probability statistics. Accounting and statistics have developed with very little constructive communication between the two professions and it is often difficult for the accountant and the statistician to understand each other. Too often statisticians have appeared in the role of mere manipulators of accounting data, while the accountant's prime responsibility for providing management with information needed for control is seldom the statistician's conception of the accounting profession.

There can be no question but what the potentialities of statistical techniques require the accounting profession to re-examine many of its data processing criteria. In data accumulation and processing, unnecessary costs are often incurred because accounting standards of accuracy are used in the quantification of data for planning and control. However, management seldom needs the same high accuracy for control, which is required when accounting for the company's cash. Hence, before information is gathered and processed, accountants should determine just what degree of precision is required for planning and control. In so doing, they cannot afford to neglect scientific techniques which are being successfully used in other professions where the problems of analysis and interpretation are just as difficult as in the accounting field.

Principles of the Statistical Performance Chart Apply to Standard Cost

Perhaps the easiest way to see how probability sampling and statistical controls can help the cost accountant is to take a simple application of statistical controls and then see how the same principles can be used in cost accounting. Suppose data for a period of several months show the daily errors in the handling of cash receipts by 60 to 70 cashiers. In this example, the daily average error varies from plus 95 cents to minus 30 cents with an over all average of plus 12 cents. Since human errors cannot be

prevented but, at best, minimized and controlled, the statistician directs his analysis to examing the range of variation in the individual and daily error rates. By use of probability theory, it is possible to measure or approximate the range of variation which must be considered normal. Then daily results (average error rate) which exceed the range of normal variation must be interpreted as indicating a major error or a series of smaller errors needing investigation. In this example the range of normal variation is plus or minus 46 cents. Thus 12 cents plus or minus 46 cents gives the upper and lower control limits of plus 60 and minus 34 cents, respectively. The upper and lower control limits of the standard statistical performance chart merely indicate the range of normal variation. Daily results which fall inside these limits can be accepted as satisfactory while results falling outside indicate unsatisfactory performance.

Objection may be raised that the standards embodied in the control limits are based on actual performance and do not indicate what could be done if the employees gave greater attention to accuracy. Some might regard them as defective for this reason. The answer is that the statistical performance chart is a proven tool which can do a better job than anything else available. It should not be neglected because we might like to have something even better. The fact that it takes conditions as they are does not mean it is a static tool. If better supervision or improved systems and procedures bring about a fundamental reduction in the number and amount of errors, this will be immediately reflected in the data and the statistician provides for revising the upper and lower control limits in order to reflect the improved performance.

The principles of the statistical performance chart, as illustrated with data on cashier errors, are directly applicable to the problem of cost control. (This will be made concrete by illustrative data). It is perhaps easiest to see this in the case of standard costs. The following brief quotations from N.A.C.A. research studies indicate that the cost accountant and statistician have the same basic approach to cost control:

> "Cost control has as its objective production of the required quality at the lowest cost attainable *under existing conditions.* It pre-supposes a plan or program which is embodied in a set of standards specifying how each job is to be done and what it ought to cost to do it. Operation under the standards then proceeds by comparing actual costs with the standard costs as the work is being done and by taking appropriate action to correct *unfavorable deviations from the standard costs* as such deviations occur." (*How Standard Costs Are Being Used Currently*, N.A.C.A. Research Series No. 11-12-13-14-15. Italics supplied.)
>
> "While the primary aim of management should be to obtain compliance with standards, perfection cannot be obtained in either standards or practice and *some variances will always arise.*" (*N.A.C.A. Bulletin*, August 1952, Research Series No. 22, *The Analysis of Manufacturing Cost Variances.* Italics supplied.)
>
> "Standard costs tell what costs should be and actual costs tell what costs have been. Variances constitute a connecting link between standard costs and actual

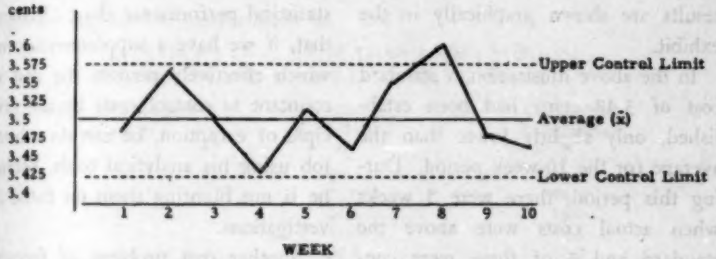
DAILY COST (CENTS) OF PRODUCTION FOR A TOILETRY ARTICLE FOR A 10 WEEK PERIOD

(Data for Four Days in Each Week)

	1	2	3	4	5	6	7	8	9	10
	3.41	3.57	3.51	3.42	3.56	3.41	3.62	3.60	3.42	3.42
	3.55	3.60	3.46	3.49	3.50	3.48	3.52	3.55	3.56	3.55
	3.40	3.51	3.49	3.36	3.58	3.45	3.51	3.59	3.49	3.47
	3.55	3.56	3.55	3.47	3.46	3.50	3.56	3.55	3.47	3.43
Total	13.91	14.24	14.01	13.74	14.10	13.85	14.21	14.40	13.94	13.87
Average	3.48	3.56	3.50	3.43	3.52	3.46	3.55	3.60	3.48	3.47
Range	.15	.09	.09	.13	.12	.09	.11	.11	.14	.13

Grand Average ($\bar{\bar{x}}$): 3.50
Average Range ($\bar{R}$): .116

Performance Chart for Above Data



Upper Control Limit: $\bar{\bar{x}} + A_2\bar{R}$ 3.50 + (0.729) (.116), 3.50 + .08 = 3.58
Lower Control Limit: $\bar{\bar{x}} - A_2\bar{R}$ 3.50 - (0.729) (.116), 3.50 - .08 = 3.42

EXHIBIT 1

costs. Since management's goal is operation of the factory at standard cost, *significant deviations from standard costs* signal the need for managerial attention to conditions which are the source of variances." (ibid.)

This is where probability statistics enters the picture. The "some variances (that) will always arise" are those non-significant deviations from standard cost which are inherent in the nature of things. They cannot be eliminated even by perfect cost control or by perfect operations. They are what the statistician calls normal variation. Thus, the significant variances with which the cost accountant is concerned are the same as the non-normal variations the statistician is able to identify, because he has found ways of measuring normal variation.

Less Investigation, More Control

The cost data in Exhibit 1 show the daily production cost for a mass-produced article. In order to simplify the calculations, four days out of each week have been used. The average

cost for each week is an unweighted average of the daily costs for the four days. The range is the difference between the highest and lowest daily cost figure. This is used by the statistician as a measure of the amount of normal variation. For the data in this illustration, the range is multiplied by 0.729 (This factor is determined so that the chances of a greater deviation from the average is less than 3 out of 1,000.) and this is used as the range of normal variation above and below the grand average of 3.5 cents. These results are shown graphically in the exhibit.

In the above illustration, a standard cost of 3.48 cents had been established, only slightly lower than the average for the 10-week period. During this period, there were 5 weeks when actual costs were above the standard and 3 of these were considered significant by the cost accountant. Probability statistics shows only one week with a significant cost variance. If the statistical performance chart is correct, more effective cost control would be obtained by concentrating investigation and analysis on operations during the eighth week. Equally important is the fact that looking for trouble where none exists is likely to create problems, particularly in personnel relations.

In this case, the usual investigations turned up nothing on any of the three days investigated which could not be satisfactorily rationalized by the production department. Nevertheless, one of the cost accountants received permission for a more detailed and thorough examination of operations during the eighth week and, as a result, uncovered a condition which may make it possible to reduce the average cost by as much as 5 per cent. This demonstrates something much more important than just the validity of the statistical performance chart. It shows that, if we have a supplementary tool which effectively permits the cost accountant to control costs by the principle of exception, he can do a better job using his analytical tools, because he is not blunting them on futile investigations.

Another cost problem of frequent occurence is to decide whether costs at two different locations, perhaps at different branches, are significantly different. Probability statistics can be of considerable assistance in evaluating data for two or more branches. There are many such situations in industrial, commercial, and service companies. As one problem of this type, the number of coupons processed per man-hour at two redemption centers is shown below for a 10-week period:

NUMBER OF COUPONS HANDLED PER MAN HOUR

Week	1	2	3	4	5	6	7	8	9	10	Average
Branch A	501	525	510	536	507	518	512	522	503	527	516.1
Branch B	508	522	495	509	518	513	495	502	509	499	508.1
Diff. (A-B)	+7	—3	—15	—27	+9	—5	—17	—20	+6	—28	

Branch A averaged 516.1 coupons, compared with 508.1 coupons at Branch B. If prizes were being awarded for superior performance, obviously Branch A would receive the award. However, the cost accountant's problem is to determine whether performance at Branch A is significantly better than at Branch B and, if so, to find out why. Again, only enough data have been used to illustrate the probability principles involved.

The statistician approaches the problem by asking what kind of results would be expected if performance at the two branches is, despite appearances, essentially the same. If this were true, then on the average Branch A would have better performance than B 50 per cent of the time. Each Branch would have the same chance of coming out on top. A statistical model of this hypothesis consists of ten symmetrical coins with A replacing heads and B replacing tails. Suppose we consider tossing these ten coins. The probability of getting various results are shown in the table below:

PROBABILITY OF A BETTER THAN B ON HYPOTHESIS THAT A AND B HAVE SAME PERFORMANCE

Number of Times A Better than B	Probability of A Better than B	Cumulative Probabilities
	%	%
0	00.1	100.0
1	01.0	99.9
2	04.4	98.9
3	11.7	94.5
4	20.5	82.8
5	24.6	62.3
6	20.5	37.7
7	11.7	17.2
8	04.4	05.5
9	01.0	01.0
10	00.1	00.1

If we accept 7 heads as indicating that A is better than B, we would also accept 8, 9 or 10 heads as indicating A is better than B. In the foregoing table we see that the probability of getting one of these results is slightly more than 17 in 100 (cumulative column).

Now, if A and B are actually on a par, it is just as likely B will be ahead of A and thus there are 17 chances out of 100 that B will have the better performance on 7, 8, 9 or 10 weeks of the ten-week period. This means, if results shown in the 10-week table are interpreted as indicating superior performance at Branch A, the cost accountant will be looking for causes of differences in performance when, 34 per cent of the time, none exist.

For the purpose of illustrating more basically that accounting data do conform to the laws of probability and of providing another instance in which

control efforts can properly be minimized, experimental data from a punch-card operation are shown in the following table:

PUNCHING ERRORS ON 10,000 IBM CARDS
100 Samples of 100 Cards Per Sample
Average Error Rate 0.8%

Number of Cards with Errors	Group of 25 Samples 1-25	26-50	51-75	76-100	Cumulative Grouping 1-50	1-75	1-100	Theoretical number of cards expected
0	9	12	15	15	21	36	47	45
1	11	9	5	6	20	25	35	36
2	2	3	4	3	5	9	12	14
3	3	1	1	1	4	5	6	4
4								1
Total	25	25	25	25	50	75	100	100

Punch-card data are used because the applicability of statistical controls to controlling punching errors is now well established. There are good reasons for thinking errors on punch cards will be distributed according to the Poisson probability law. In order to test this, samples of 100 cards with errors were recorded. The results of the first 25 samples, of 100 cards each, is shown in the first column of the above table. One hundred samples were taken and the results for each group of 25 samples appear in the table as well as the cumulative results. In all, 10,000 cards were verified in this experiment. The last column in the table gives the number of cards that would be expected to have errors, on the average, if the errors on punch cards are distributed according to the Poisson probability law.

The agreement between theoretical and actual results is so close that we are safe in concluding that punching errors, at least for the operation studied, follow this law. Having established this basic fact, we can then say, so long as the average error rate remains close to 0.8 per cent, the chances of getting more than three cards with errors in a sample of 100 cards is less than 1 in 100. From zero to three errors is the range of normal variation and any sample with more than three cards with errors indicates the error rate has probably risen,—and requires investigation.

Research Is Required for Most Accounting Applications

The purpose of the foregoing examples has been to give the cost accountant some appreciation of what probability statistics and statistical controls have to offer to cost accounting and to illustrate the probability approach to cost control. There has been no attempt to give the cost accountant the impression that he can take a kit of statistical formulas, grind a crank, and wait for the answer. In fact, considerable statistical research is required to be sure that the correct probability laws are used.

However, the cost accountant can proceed with considerable confidence

in the expectation that cost variances and other cost data will obey the mathematical laws of probability. These probability laws are universally applicable to a wide range of problems in both the social and physical sciences, where variation characterizes the basic data. This, in itself, should be sufficient to convince the cost accountant that his data lend themselves to the same scientific treatment. Moreover, there is an important group of problems for which the cost accountant can use the laws of probability without any of the detailed research which would be required in the case of analysis of cost variances. It is fundamental in cost accounting to keep costs in terms of responsibility centers, so that departments and individuals responsible for incurring expenses can be held accountable for results. In the case of service departments, the maintenance of records as to who uses the service and how much, can run prohibitively high. By the judicious use of probability sampling, these charges can be determined with an acceptable degree of accuracy at a fraction of the cost. For example, the distribution of trucking service expenses to the various department users within a plant becomes a large expense item if records must be maintained and tabulated on all trucking operations. By the use of probability sampling these expenses can be distributed at a fraction of the cost to complete tabulation, and the sampling error may be no greater than the clerical errors in the complete tabulation.

The Laws of Probability Have Many Applications

Life insurance is probably the outstanding example of a business use of probability theory. Here we have one of the largest industries in the nation relying on the laws of probability in setting premiums on contracts which can run for a life term. Agricultural experimentation has been using the laws of probability for the past fifty years. Many of the important contributions to statistics and probability theory have been made by scientists at the agricultural experiment stations.

These same techniques are now being used in all scientific laboratory experimentation—medical, chemical, biological, metallurgical, etc.

It has been found the Poisson law applies to such diverse phenomona as the emission of B-rays from a radioactive substance, demands on a stock clerk of a warehouse, the flow of traffic on a highway, demands for service upon a sales clerk, and the number of electrons emitted from a hot metal or from photo-sensitive substance under the influence of light, and the number of errors in clerical work. In brief the laws of probability provide a universal yard stick for measuring and controlling variation. Cost variances are one type of variation. Cost accounting can increase the effectiveness of cost control by using these scientific methods.

Quality Control to Minimize Cost Variances

by JAMES C. STEPHENSON

Controller, Utopia Cleaners & Dyers, Inc., Birmingham, Alabama

Concentrating on the area of cost variance represented by product quality, the present article indicates that timely disclosure as well as disclosure of assignable causes are facilitated by statistical quality techniques in a way which neither cost analysis nor inspection routines can match. The author identifies key statistical concepts, includes a case study in cost savings through quality control, and suggests further applicability of statistical techniques.

COST VARIANCES are mirrors to management reflecting the effect on costs that certain events or conditions have produced. The analysis of variances by cause is, therefore, an important aspect of the use of standard costs to attain cost control. Very often, reports to management analyzing cost variances fail to provide sufficient information for the control of unfavorable ones.

The purpose of this paper it to illustrate how a study can best be made in a manufacturing process to obtain maximum profits, and how before-the-fact control of the image reflected in the cost variance mirror may be economically obtained. Included is a factual case study of the methods employed by one company.

Combatting Cost Variances Arising from Quality Defects

In the mass production of products, it is almost impossible to make each unit exactly the same as every other unit. Contrary to common supposition, no machine will turn out one piece after another exactly the same. It is true that the difference between pieces may be very small—measurable in hundred thousandths of an inch—but a difference does exist. A given set of characteristics of a finished product represents the highest quality of the product. Any variation in these characteristics may thus bring about a variable final product.

As long as man, machine, and material continue in a normal fashion, the product will exhibit a certain degree of variation but will product close to the same average measurement. When a change takes place which causes a change in the average amount of variation, some assignable cause is present. If the operator performs his task in a different manner and so causes the quality of the product to be reduced, the operator is the assignable cause. If a machine-stop slipped, if a cutting tool becomes chipped, if a condenser went bad, the

machine is the assignable cause. If the chemical or physical properties of the material changed, the material becomes the assignable cause. Defects have causes, they do not just happen. If the cause of a particular defect can be discovered, human ingenuity will probably be able to devise a method of eliminating or minimizing the cause.

Any defect control technique should, first and foremost, set up a barrier against the continued shipment of "more than the desired" percentage of defective articles to customers. Second, it should point out those defects which, because of their critical nature and/or frequency of occurrence, warrant corrective action. Two of the principal methods used to detect quality defects are inspection and quality control. These are not synonyms. Inspection is a sorting operation, usually conducted after significant amounts of material, machine time and man hours have been expended. Quality control is, in effect a tool which restrains, governs and directs the three M's, (man, machine and material) of the manufacturing process to ensure that more acceptable work will be produced in less time and at a lower cost. Quality control is a work-in-process control as compared with the end-product examination represented by inspection. One hundred percent inspection controls are expensive, time consuming, wasteful of material, space, machine time and man hours by reason of the fact that these controls are "post mortem" operations. Also, it is uneconomical to manufacture defective material and then attempt to correct it by one hundred percent inspection and rework. The rejected items, by reason of special handling, rework or repair, will invariably cost more than the accepted items.

Obviously, a replacement for the inefficient sorting of good from bad after a product has been produced represents industrial progress. The progressive replacement is quality control, which means exactly what the name implies—that the quality of products are controlled from the first through the last productive operation, making certain that they conform to specifications set up by the manufacturer. The principal objective of a quality control program is to minimize losses due to manufacture of defective products. There are two general categories into which these losses fall. One is loss of good will as a result of a defective product which finds its way to the customer. The other is excessive internal costs incurred to prevent this from happening, such as high rate of scrap and rework, downgrading of product and excessive inspection costs.

Statistical Indications More Revealing than Cost Analysis

The interpretation of cost variances is usually developed through analysis made by the cost analyst or cost ac-

countant working in close collaboration with production and engineering personnel. There are two serious weaknesses in placing too much dependence upon monthly cost analysis for control. The first is the delayed reporting which might involve waiting until the middle of the following month to learn that an operation fell below standard the first part of a month. The second factor is that monthly costs often represent a heterogeneous set of operations covering many days, machines, and crews, and typifying none of the actual operations. Under such conditions, it is difficult either to find the causes of high cost variations or to place responsibility for them below the supervisory level.

The analysis of differences between standard cost and actual cost by an accountant located at the scene of operations provides a very necessary service in breaking down and isolating the factors which cause unfavorable variances. Analysis is not always the best or final answer to cost reduction. Generally, analysis does not probe deeply enough to find the answer necessary for removal of all causes and thereby obtain a maximum profit. The solution, in most instances, can be found by going one step beyond cursory analysis. This step is statistical quality control. After all obvious corrective action has been taken and normal logic indicates no further savings are possible by analysis, statistical methods may still point toward a reasonable chance for still further savings.

The ideal quality control is to detect bad parts while they are being made. By statistical methods—frequent sampling of mass-produced parts—it is possible to maintain the optimum quality level at each machine. If the output of one machine drops below an established quality level, a correction is made in the machine, if it is the cause. If the operator is at fault, a change is made in his methods of operation.

Relating the Normal Curve and Standard Deviation to Manufacturing

Variations in dimensions and other quality characteristics of industrial products are related directly to probability principles. These principles are now better known and understood than heretofore. After mathematicians observed many similar patterns of variation, they learned that there is some underlying law of nature, some standard pattern which all data tend to approach. They attempted to describe the pattern by formula and eventually obtained a curve which was common or similar to almost all patterns. This curve is referred to as the normal curve, a symmetrical curve about the average. It is high in the middle and diminishes as the distance away from the average increases. It applies in manufacturing processes just as much as in insurance mortality tables or

in games of chance. The normal curve indicates the usual or common distribution of the specific group (universe) of measurement data. To fully describe the curve, in a particular case, we must know the average or arithmetic mean, and the standard deviation. The average locates the central value or middle of the universe. The standard deviation indicates how much spread or dispersion exists about this average, i.e., it is a measure of the dispersion from the average. If the data varies only a little, the standard deviation will be small. If the data varies a great deal, the standard deviation will be large. In statistical terminology, a standard deviation is referred to as a one-sigma, two-sigma, three-sigma, etc., deviation.

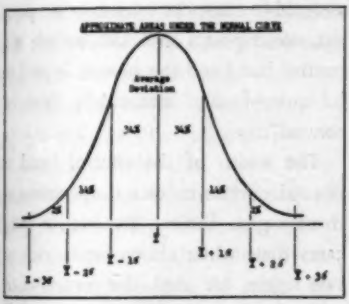


EXHIBIT 1

Exhibit 1 shows a normal curve and illustrates how the dispersion of measurements is described by the standard deviation. An interval from the average to plus, or minus, one standard deviation will include approximately thirty-four percent of all the individual measurements. This is true of any measurement data which is distributed as a normal curve. From this information, we know that, if limits are set at one-sigma deviation, we can predict that approximately sixty-eight percent of all measurements will be within and thirty-two percent will fall outside the limitation. If two-sigma deviations are selected, we can predict that approximately ninety-six percent of all measurements will fall inside and only four percent outside the limit. Practically all measurements will fall within three sigma deviations.

In manufacturing process control, information is desired to determine that parts being produced conform to specification. To accomplish this, the parts are periodically sampled and inspected during the manufacturing process. From the results of this inspection, a decision is made regarding all the parts being produced. In statistical terminology, it is said that information is obtained regarding the universe based upon samples taken from it. We have no more interest in the five pieces selected as a sample than in any other five pieces involved. We wish to know about all, and the samples provide the data, because they will contain an almost exact pattern of the variation of all. From sigma, we can then predict the upper and lower limits or range of the measurements of an unknown process spread. A comparison of these predicted limits within specification tolerances will

determine the approximate number of units being produced within the specification, or between any other desired limits.

Control Charts Channel Attention to Variances with Assignable Causes

By statistical methods, the quality variations in manufactured articles may be separated into two types of causes:

1. Chance variations—random variations inherent in the nature of the process and not within management's power to remove or regulate. Variation within this stable pattern is inevitable.
2. Assignable causes—nonchance variations outside the stable pattern which are potentially detectable and within management's power to remove or regulate. An assignable cause changes the pattern of variation and can be detected by comparing the erratic or unstable pattern actually existing in a process with the stable pattern that would be expected if chance or inherent causes alone were operating.

Statistical control charts are the tools used to separate chance from assignable causes of quality variation. These charts provide their greatest benefit by detecting, at the earliest possible time, variations which create defective material. Control charts are also valuable to management in obtaining knowledge of the costs associated with the various degrees of consumer protection against receiving defective products. There are three types of control charts in general use, but all kinds constitute a graphical record or running picture of the quality of current production, showing quality variations by a series of points plotted in the order of production. Some people compare their control charts with a patient's temperature chart in a hospital. A temperature chart indicates to the doctor a good general sign of the patient's state of health and if the patient is in trouble and needs special attention.

A control chart has the features indicated in Exhibit 2. The central line of the chart indicates the specification which is expected. The points plotted on the chart vary above and below this line. The upper and lower control limits assist in judging the significance of the quality variations from the central level. When only chance causes of variation are operating, the points fall inside the control band and are randomly dispersed about the center line. The process is then said to be stable and statistically in control. If assignable causes of variation are present, some points will fall outside the control band and the process is said to be unstable and statistically "out of control".

The width of the control band is normally set in industrial operations at three sigma limits. Experience indicates that, when closer limits such as two sigma, are used, the control chart will often give indications of assignable causes that simply cannot be found. Whereas, when three-sigma limits are used, a diligent search will usually disclose the assignable cause of variation in quality. Points falling inside the control band do not necessarily indicate the presence of only

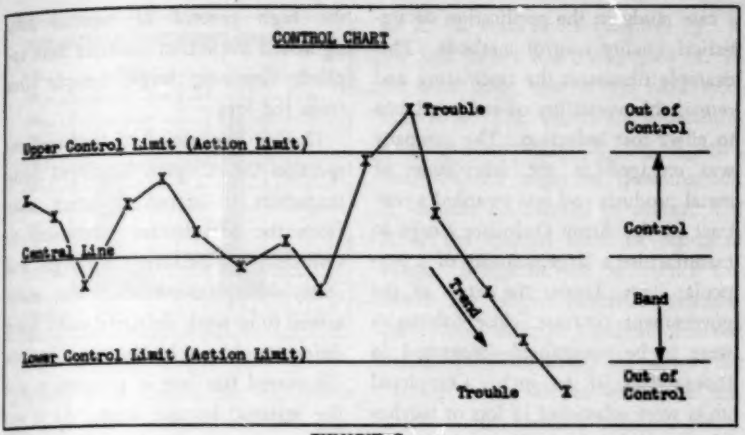


EXHIBIT 2

inherent or chance causes. Seven or more successive points on the same side of the central line may have the same significance as that of a point falling outside the control band. Control charts are also used to reveal trends. If the plotted points indicate that the process average is drifting away from the desired level, corrective action may immediately be required.

Engineers use this information in establishing a basis for sound tolerances consistent with the economy of the operation. The chart may show that tolerances are tighter than necessary. The old method of arbitrarily setting tolerances and *hoping* to produce material within those limits has become obsolete. Also, the practice of using one machine as a basis for making inferences regarding quality and production costs on similar machines in the plant is likewise out of date.

Similar statistical problems face the quality control manager and the analyst or cost accountant. Both collect large masses of cost and other data. They need the help of statistical charts and methods in the collection, tabulation, analysis, and interpretation of these data. For example, a proper evaluation of in-process information probably will show that a small percentage of operators and machines creates a very large percentage of the defective work. Armed with this information, management can spotlight poor operators and machines and scientifically measure the results of corrective action. Statistical controls reduce costs by enabling management to take prompt action in problem situations that are in the greatest need for attention.

A Case in Substitution of Quality Control for Inspection

The following paragraphs consist of

a case study in the application of statistical quality control methods. This example illustrates the fascinating and remarkable versatility of statistical data to effect cost reduction. The company was engaged in the fabrication of metal products and was awarded a contract by the Army Ordnance Corps to manufacture a large quantity of a particular item. Under the terms of the government contract, close tolerances were to be maintained—measured in thousandths of an inch. Completed units were submitted in lots or batches of several hundred, from which resident Ordnance Corps inspectors drew samples in accordance with standard governmental inspection procedures. Production commenced with a metal slug which passed through forging and successive machining operations. A large number of metal removing and working machines, both contractor and governmental owned, were employed. The bid price and physical cost standards were set from engineering studies and other data.

Difficulty was immediately encountered in producing a unit which would pass inspection. Rejections were high because of failure to hold tolerances on dimensions. In some instances an inspection lot, after one hundred percent inspection before each submission, was submitted to Ordnance inspectors as many as five times before being accepted. At first, normal inspection practices were followed by the Ordnance inspectors, but, due to the high percent of rejected lots, tightened inspection practices were applied, requiring larger samples taken from the lots.

During this period of tightened inspection the company employed thirty inspectors to screen defective units from the lots before submission to Ordnance inspectors. A large and costly "hospital" facility was maintained to re-work defective units. Some defects could not be corrected, because discovered too late in processing, and the material became scrap. As it was necessary to maintain a backlog of semi-finished units at inspection points awaiting acceptance or rejection, the flow of work was constantly disrupted or cut off entirely by rejected lots. Under these conditions, cost variances generated in the standard cost system were almost useless for cost or production control.

The management of the company, realizing that the situation was intolerable and that drastic action was needed, agreed to the suggestion of Ordnance Corps officials to apply statistical quality control charting to the various machining processes, with the aim of localizing and eliminating each defect of manufacture. Exhibit 3 compares the average percentage of accepted lots at each submission before with the average percentage accepted two months after the charts were introduced. It is noted that only twenty-two per cent of the lots were accepted on first submission before control

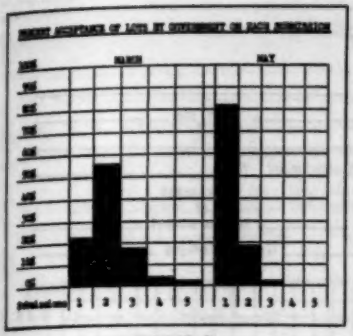


EXHIBIT 3

methods were applied but eighty-one per cent were accepted on first submission two months later. This improvement in quality resulted in savings in cost under the contract of several hundred thousand dollars.

After it was determined what characteristics required immediate attention, the Shewharts control chart for variables, which has become known popularly as the $\bar{X}$ - R chart, was selected as it is the most potent tool in the kit provided by statistical quality control. This type of chart lends itself to trouble-shooting work where the dimension itself is the quality characteristic that is desired to be controlled and the data is collected in actual measurement. It is exemplified by Exhibit 4.

Five random samples of the measurement to be checked were drawn from the machine's production by a roving inspector at regular intervals. The samples were carefully measured and the variation from the specification dimension was entered in code in an $\bar{X}$ - R Data Sheet (Exhibit 5). A + .002 inches was coded as + 2. In the data sheet, one of the basic symbols is X. This stands for a measurement or observation. X_1, X_2, X_3, etc., indicates the order of measurement. $\bar{X}$ denotes an average of several X's. R is the symbol used to represent range. Range is the difference between the largest observed measurement value and the smallest observed value. It is necessary to know the "range" of a sample because a machine might produce two groups of parts having the same average X. This fact might lead to the belief that the machine at both times is turning out the same quality of production, when actually it is not as one unit of a sample may be very good and another partly scrap. In control chart work in industry, range rather than the standard deviation (sigma) is used.

Chart and data sheets were maintained in close proximity to each machine. At the end of each work shift, these data were analyzed. This analysis procedure consisted of calculating center lines and control limits for the charts. The grand average of $\bar{X}$, the symbol of which is $\bar{\bar{X}}$, was obtained. Also the average range, the symbol of which is $\bar{R}$, was computed. The grand average and average range were drawn on the charts. By the use of simple statistical formulas which can be obtained from statistical handbooks, the Upper and Lower Control Limits for Averages, $UCL_{\bar{x}}$ and $LCL_{\bar{x}}$, the Upper and

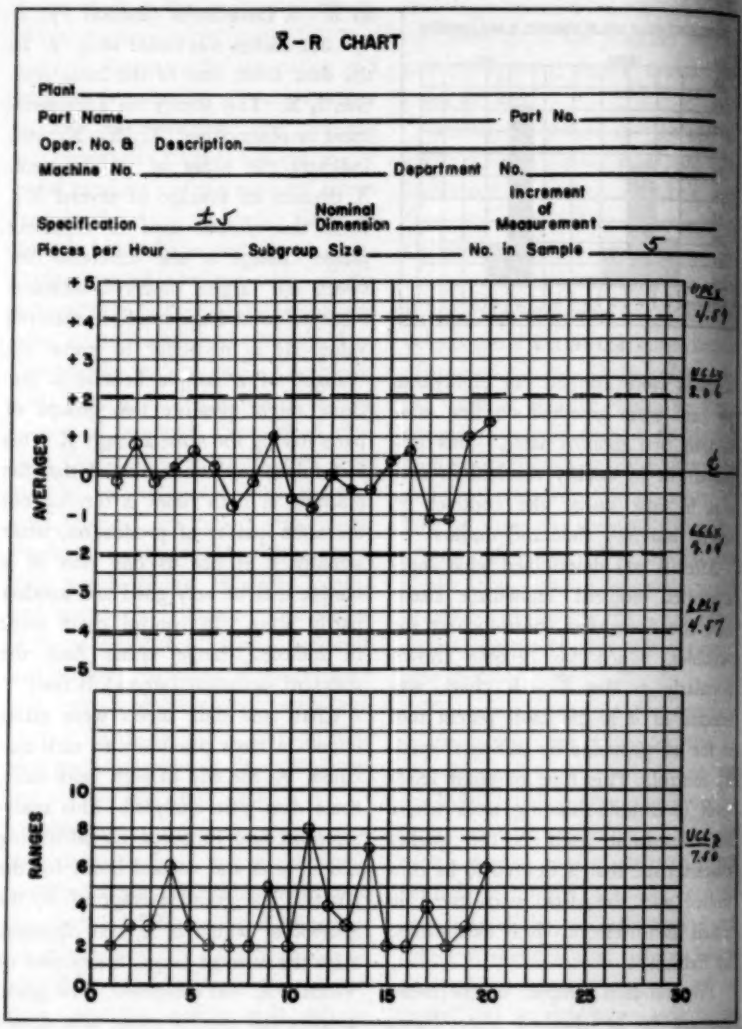


EXHIBIT 4

Lower Control Limits for Range, UCL_R and LCL_R, and the Upper and Lower Predicted Limits for the Process, UPL_x and LPL_x, were computed and drawn in the chart as broken lines, as shown on Exhibit 4. These lines were drawn in color to more vividly present to the operators the results of maintaining the

$\bar{X}$-R DATA SHEET

Plant _____

Part Name _____ Part No. _____

Oper. No. B Description _____

Machine No. _____ Department No. _____

Specification ± 5 Nominal Dimension _____ Increment of Measurement _____

Pieces per Hour _____ Subgroup Size _____ No. in Sample 5

NO.	X1	X2	X3	X4	X5	$\bar{X}$	R
1	+1	-1	0	-1	0	-.2	2
2	0	+1	-1	+2	+2	+.8	3
18	-2	0	0	-2	-2	-1.2	2
19	+1	+1	+3	0	0	+1.0	3
20	0	+4	+3	-2	+2	+1.4	6
					TOTALS	+.2	71
					$\bar{\bar{X}}$-R	+.01	3.55

Calculations

$UCL_{\bar{X}}$ = +2.06
$LCL_{\bar{X}}$ = -2.04
UCL_R = 7.50
UPL_X = +4.59
LPL_X = -4.57

EXHIBIT 5

process within the desired limits.

The dividends from this information on the control chart came from the application of the control limits to future production. A continuation of the chart permitted the identification of the assignable causes of variation in the average—principally related to machine setting or condition—and the assignable causes of variation in the range, which was generally related to carelessness of a particular operator. Data from a satisfactory production run were used for establishing limits covering future production. It was realized that, if a machine could produce satisfactorily within tolerances on one occasion, it should be possible to do so at a future period.

In this case study, it was found that a majority of all machining operations were out of control to some extent. The diagnosis showed that some machines, due to wear and improper maintenance, were so subject to variation that they caused a too-wide process spread or an incorrect centering of the process between specification

limits. It was also found that most operators were frequently stopping machines to make unnecessary adjustments that tended to increase rather than to decrease the variability of the process. Some causes were multiple and interacted, thereby making them difficult to locate. Another problem was the determination of the capacity of each machine to consistently meet the close tolerances specified in the contract and to judge the adequacy of the facility to produce the part. It was discovered that some machines were not capable of producing the item within specification tolerances. These machines were repaired, exchanged or removed. Some close tolerance operations were assigned only to machines which could produce within them.

A card, green on one side and red on the other, was attached to each chart in the plant. When the presence of an assignable cause of poor quality was indicated by the plotting on the chart, the card was turned over to red and production management immediately notified. This prompt investigation to ascertain assignable causes as soon as a point went out of control gave opportunity for their immediate discovery and correction. Every chart, where possible, was placed directly in front of the operator's working area so he could observe the improvement or changes reflected by the chart. In this way, he compared the results of his efforts with that of his neighbor. The psychological effect was "terrific". A steady improvement in quality of work became evident early in the program. Good operators became better operators. The bad operators stood out like "sore thumbs" and their foreman reinstructed them or changed their jobs.

Several months after the installation of statistical quality control, the Ordnance Corps returned to normal inspection practices. After the required number of lots under normal inspection had been accepted and none rejected, the Corps instituted reduced inspection. Under reduced inspection, a large percentage of both government and company inspectors were eliminated with substantial savings to both parties. In short, statistical quality control was an economic necessity in this plant as hidden costs were obviously both present and difficult to control by any other method. The program made it possible to abandon one hundred per cent inspection, with an increase in product quality. This bears out the old adage that "quality must be built into a product; it cannot be inspected there".

Present and Future Accounting Uses of Probability Data

Probability statistics help build quality into an object because it builds quality into data, decisions, and performance. The control chart is the most effective method yet found for

presenting quality data on the production line. It can be as valuable in the presentation and interpretation of cost data. The standard cost system, when aided by statistical methodology, becomes an accurate and effective means of developing and analyzing cost data for before-the-fact control. Statistical methods assume their greatest importance and value when competition is keen, quality of materials and products must meet critical specifications and tolerances, and a small variation from specification standards can result in large losses.

The use of these methods may reach to integrity of the accounting process itself. Statisticians do not yet know the full range of application of this science. Apparently what has been done to date has only scratched the surface. Experience has shown that it can be applied in the office as well as in the factory, to production as well as to research, to service and finance organizations as well as to manufacturing operations, to persons as well as to machines. In this direction, several instances have been reported in accounting literature of successful applications of quality control techniques for solving the problems facing accountants and auditors. Clerical work is either right or wrong, and verification is the inspection process in accounting and auditing operations. Reported applications have included the test-checking of invoices and payroll calculations, inventory verification, confirmation and aging of accounts receivable, clerical errors in filing, the settlement of accounts between air lines or between railroads from vast quantities of waybills, and many other activities. Even so, the field of accounting and auditing is still virgin territory for quality control.

It is in the field of control that the accounting function plays the key part and it is also here that this new management technique can sharpen some of the tools of accounting. Statistical quality control is being rapidly accepted by industry and it shares in the making of a company's financial statement. Production cost and quality are interrelated and, for the proper overall management of an operation, it is important for management to have quality performance figures fully as much as on cost and production. Accountants must grasp this powerful and versatile science and apply the data it develops if they are to carry out their primary control responsibility to management. Yet, they need not go beyond the frontier of simple arithmetic to do and understand statistical work. Moreover, there is missionary work to do. The greater the number of persons holding positions of responsibility in an organization who understand statistical controls, the better the chance will be for all the possible cost-saving applications to be made.

Notes on Current Reading

Books

Basic Accounting and Cost Accounting

Eugene L. Grant, McGraw-Hill Book Co., Inc., 330 West 42nd St., N. Y. 36, N. Y., 1956, 377 pp., $6.00.

"For every professional accountant," states the author of this book, "there are dozens of other persons in industry and government who need to understand the basic concepts of accounting." He directs his work to this group, primarily, with three sections on, respectively, "Accounting Fundamentals," "Elements of Cost Accounting" and "Some Accounting Topics" (among them "Budgetary Control"). The section on cost accounting comprises well over one-third of the text and appears to represent a considered emphasis on this side of the topic.

Proceedings of the Eighteenth Annual Institute on Accounting

Ohio State University, Columbus Ohio, Paper Bound, 1956, 103 pp.

Promptly issued, this report of last May's Ohio State Accounting Institute contains the eight papers there presented and other aspects of the proceedings. The papers include "Management Advisory Services in Accounting," "Responsibilities of the Accounting Profession," "Internal Control Applications," "Looking Ahead in Accountancy Education," "Corporate Accounting Standards Under Federal Securities Laws," "Partnership Distributions and Liquidations," "Compensation Arrangements for Executives and Employees," and "The General Accounting Offices (U. S. Government) Today."

Industrial Storeskeeping Manual

Benjamin Melnitsky, Chilton Company, Chestnut and Fifty-Sixth Sts., Philadelphia 39, Pa., 1956, 279 pp., $6.00.

No longer just the "man with the memory" (to borrow a phrase from the preface of this book), the storeskeeper in a manufacturing plant—often with a staff—presides over a complex operation which is a part of the logistics process of his company —how to be there with the right amount of the right material at the right time. Typical chapter headings in this book, one of seventeen in all, are "stock numbers and names," "cutting paperwork costs," "location systems," "storage and issuance" and "physical inventory."

Management in Action

Laurence A. Appley, American Management Association, 1515 Broadway, New York 36, N. Y., 1956, 382 pp., $5.00.

The interest-arousing title of this book is supplemented by an attractive subtitle, "The Art of Getting Things Done Through People". The 84 chapters, which are short, are intimate chats also. Despite absence of specification in title or subtitle, the management to which reference is made is, as expected, that of a business organization —but in terms of individuals. Central in position and spirit is one section of seven chapters in which "A Personal Philosophy of Management" is set forth.

Retention and Preservation of Records with Destruction Schedules

Record Controls, Inc., 209 South La Salle St., Chicago 4, Ill., paper-bound, fifth edition, 1956, 46 pp., $4.00.

Beside procedural description and recommendations, this pamphlet-form publication includes provisions of state laws affecting retention of records, as well as a "tabulation of over 250 common papers found in a normal business office, with length of time retained". The eight-page listing of these papers has a notation, as to each paper named, of the number of companies reporting it in the underlying survey.

SELECTED ARTICLES FROM ACCOUNTING PERIODICALS

THE ACCOUNTING REVIEW, *July* 1956 (College of Commerce and Administration, c/o Carson Cox, Ohio State University, Columbus 10, Ohio, single copy $1.50)

Choice Among Alternatives. A. C. Littleton.
Reporting on the Flow of Funds. Maurice Moonitz.
Accounting for Guaranteed Wage Plans. Robert E. Seiler.
That Application of Funds Statement. W. B. Castenholz.
The Relative Importance of Fixed Assets. Harold G. Avery.
Joint Cost Analysis as an Aid to Management — A Rejoinder. Gerald H. Lawson.
Non-Linear Depreciation. Lewis A. Carman.
Try This on Your Class, Professor. Raymond P. Marple.

THE ARTHUR YOUNG JOURNAL, *July* 1956 (Arthur Young & Company, 165 Broadway, New York, N. Y.)

The Reserved Oil Payment. Paul R. Keene.

THE CONTROLLER, *August* 1956 (2 Park Avenue, New York 16, N. Y., single copy $.50)

Controllership and Cost Accounting. James L. Peirce.
A Cost System for Food-Processing Company. Louis J. Smitten.
Devaluation of Foreign Currencies. John J. Miller.

COST AND MANAGEMENT, *July-August* 1956 (31 Walnut St. So., Hamilton, Ontario, Canada, single copy $.50)

Cost Reduction. L. A. Stock.
The Budget — Measure of Success. V. A. Rybeck.

ILLINOIS CERTIFIED PUBLIC ACCOUNTANT, *Summer* 1956 (208 South LaSalle St., Chicago 4, Illinois, single copy $.40)

Economists and Accountants. A. C. Littleton.
Accounting Problems in Guaranteed Annual Wage Plans. Thomas D. Flynn.

JOURNAL OF ACCOUNTANCY, *August* 1956 (270 Madison Ave., New York 16, N. Y., single copy $.75)

Twenty Years of Social Security. Donald F. Campbell, Jr.
Organizations and Reorganizations. Waymon G. Peavy.
Corporate Liquidations. T. T. Shaw.
Dividends and Stock Redemptions. Mark E. Richardson.

L. R. B. & M. JOURNAL, *January-March* 1956 (Lybrand, Ross Bros. & Montgomery, 90 Broad St., New York 4, N. Y.)

Inventory Pricing for Changing Economic Conditions. John J. Fox.
Some Observations on the Future of Electronic Data Processing. Theodore R. Plaim.

L. R. B. & M. JOURNAL, *April-June* 1956

Depreciation Under New Regulations. Raymond E. Graichen.

THE NEW YORK CERTIFIED PUBLIC ACCOUNTANT, *August* 1956 (677 Fifth Avenue, New York 22, N. Y., single copy $.50)

An Example of Advisory Services by C.P.A.'s. Paul W. Pinkerton.
Production and Inventory Controls in Apparel Manufacturing. Louis J. Klein.

Proceedings of the Conference on Case Studies in Operations Research

Operation Research Group, Case Institute of Technology, Cleveland, Ohio, Paper Bound, 1956, 64 pp., $5.00.

Subtitled "a cross section of applications in business and industry", this report represents cases in operations research and its progress in problems solving, together with at least one survey article and one general article on the organization of the activity.

SELECTED ARTICLES FROM BUSINESS PERIODICALS

ADVANCED MANAGEMENT, *July* 1956 (74 Fifth Avenue, New York 11, N. Y., single copy $.75 to members, $1.00 to nonmembers)

Small Business in America — Its Place and Problems. Wendell B. Barnes.
The Use and Mis-Use of Salaries Job Titles. C. J. Costello.

AMERICAN BUSINESS, *July* 1956 (4660 Ravenwood Avenue, Chicago 40, Illinois, single copy $.35)

Compensation of Salesmen.

BUSINESS BUDGETING (Technical Notes Magazine), *June* 1956 (National Society for Business Budgeting, The Andrew Jergens Co., 2535 Spring Grove Ave., Cincinnati 14, Ohio)

The Learning Curve Theory Applied to Production Costs. Robert H. Lundberg.
Equitable Selling Price Determination. Harry P. Kelley.
Travel Expense, A Budgeted Item. John B. Morgan.
Budgeting and Accounting in the U. S. Government. W. J. Edmonds.
The Influence of Automation on Budgeting. Alwyn M. Hartogensis.
The Growing Importance of Long Range Planning. W. F. Maxwell.

CREDIT AND FINANCIAL MANAGEMENT, *August* and *September* 1956 (33 South Clark St., Chicago 3, Illinois, single copy $.25)

Working Capital—A Key to Credit. P. M. Chiuminatto.

THE OFFICE, *August* 1956 (232 Madison Avenue, New York 16, N. Y., single copy $.35)

The "Dangers" of Waiting for Automation. William Alden & Franklin Wayman, Jr.

OFFICE EQUIPMENT NEWS, *July* 1956 (146 Bates Road, Montreal 8, Canada, $.35 single copy)

Office Automation Can Be Employed in a Medium-Sized Company. Tom Scrymgeour.

OFFICE EXECUTIVE, *August* 1956 (132 West Chelton Ave., Philadelphia 44, Pa., single copy $.50)

NOMA's 37th International Conference, Proceedings, Philadelphia 1956.

Two problem-titled papers included are "Scheduling of Motor Freight Operations" and "Determining Required Warehouse Dock Facilities".

Public Control of Economic Enterprise

Harold Koontz and Richard W. Gable, McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y., 1956, 851 pp., $7.00.

A detailed situation-review study, the topics considered in this wide-ranging but largely undefined (or uncodified) area, include transportation, public utilities, the maintaining of competition throughout industry, regulation to protect investors, public "promotion and ownership", and "public control of the total economy"—this last section being considered under heads of wartime controls and controls for stability and growth.

For Your Information

PROGRESS REPORT DUE ON REVIEW OF GOVERNMENT REPORTING REQUIREMENTS

The date of September 30 was set for "a report of—progress—(on) effective control of the paperwork burden on the public" in a letter issued before the summer by President Eisenhower to U. S. Budget Director Percival Brundage. The text of the letter, included in a release of the President's press secretary last May, follows:

Dear Mr. Bundage:

The recent report of the Commission on Organization of the Executive Branch of the Government entitled *Paperwork Management, Part II, the Nation's Paperwork for the Government* directs attention to the problem of Government requirements which impose unnecessary paperwork on the public. The report recommends:

> "That the President direct the Bureau of the Budget, together with its Advisory Council on Federal Reports and in cooperation with the General Service Administration, to give increased emphasis in their reports program to the need to protect the public from unnecessary reporting burdens by continuing the method of cooperation between industry and Government pursued by our task force as outlined above."

I endorse the Commission's recommendation that increased emphasis be placed on actions to reduce unnecessary reporting burdens on industry and the public. In recognition of the responsibilities for the improvement of government statistical activities and for the promotion of economy and efficiency in executive branch operations already assigned to the Bureau of the Budget, I believe the Bureau is the logical agency to assume leadership in such activities. A significant portion of the paperwork required of the public is associated with government forms and related reporting requirements which require your approval under the Federal Reports Act, and I am gratified at the substantial progress already made in this program by the Bureau and its Advisory Council on Federal Reports.

I wish you to give increased emphasis in this program to the elimination of reporting requirements which impose unnecessary paperwork on the public. With respect to matters not subject to review under the Federal Reports Act, I want you to proceed with the development, in cooperation with the affected executive agencies, of plans for eliminating unnecessary public reporting requirements and for simplifying related procedures and systems in such agencies.

In carrying out this program I assume that you will make maximum use of the advisory services of the Advisory Council on Federal Reports and its various specialized committees. You will also wish to consult freely with the affected Federal agencies and when appropriate with the General Service Administration. You are authorized and directed to issue such circulars or other instructions as you may find useful in carrying out this assignment.

I should like to receive from you by September 30, 1956, a report of your progress together with any recommendations you may have as to further steps required for the effective control of the paperwork burden on the public.

Increased efforts to reduce the reporting burden on the public, together with actions being taken by the General Services Administration and other executive agencies aimed at solution of paper work problems within the Government, will go far toward attaining the desirable objectives of the Hoover Commission's recommendations for improvement of paperwork management. They form a logical and valuable part of the broader responsibility and program of the Bureau of the Budget to bring about better internal business management throughout the Executive Branch.

Sincerely,

DWIGHT D. EISENHOWER

(It may be noted here that Budget Director Brundage, to whom the President's letter is addressed, is a Certified Public Accountant in Government service and an N.A.C.A. member.)